THE AMENITY VALUE OF WETLANDS

A Dissertation

by

SHAN GAO

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2010

Major Subject: Urban and Regional Sciences

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Approved by:

Chair of Committee,	George O. Rogers
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ABSTRACT

The Amenity Value of Wetlands.

(August 2010)

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Wetlands provide recreation and cultural values including scenic views, aesthetics, open-spaces, and leisure opportunities to surrounding residents. This study applies a hedonic approach to estimate the impact of wetland amenities on nearby single family homes using actual sales prices of properties from 1991 to 2005 in Chatham County, Georgia, where wetland resources are unevenly distributed in terms of types and quantities of wetlands. Separate hedonic models are investigated to understand the spatial variation of wetland amenity effects across different study areas in Chatham County.

This study finds that wetland amenity values vary mainly with the characteristics of study location. In a rural setting where wetland resources are ample and sufficient. Wetland amenities have negative impacts on the sales price of nearby single family homes. Forested wetlands, the size of the nearest wetland, and wetland proximity negatively impact the sales price of the properties. In an urban setting where wetland resources are extremely limited, wetlands have significant positive amenity effects. The size of the nearest wetland positively impact the sales price of nearby single family homes, but type of wetlands turns into insignificant. In a suburban area with diverse wetland recourses in term of types of wetlands, mixed amenity effects are found. In general immediate access to a wetland, especially a large size one, positively impact nearby single family homes. Type of wetlands plays a key role in deciding the direction and magnitude of wetland amenity effects in a suburban area. The findings of the study suggest that policy makers need to think about both the characteristics of wetlands and their spatial context when providing or protecting wetland amenities.

DEDICATION

I would like to dedicate this work with all my heart to

My mother, Shu-ping Shi

For your endless love and patience

My father in heaven, Ke-wa Gao

A peaceful mind always delivered deep thoughts

My sisters, M.D. Hai-yan Gao & Hai-wen Gao

For intimate sisterhood bonds.

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CHAPTER I

INTRODUCTION

1.1 Problem Statement

A single family home's value is determined by the dwelling's structural characteristics, neighborhood characteristics, and levels of convenience to access various locational amenities including environmental amenities. As an environmental amenity, wetlands provide scenic views, green spaces, and recreational opportunities to nearby residents. Brander Florax, and Vermaat (2006) conducted a meta-analysis summarizing 190 wetland valuation studies that estimate the economic value of wetlands functions and services. Of them, a few studies have discussed the economic impacts of wetland amenities on residential property values (Lupi, Graham-Tomasi, and Taff 1991; Doss and Taff 1996; Mahan, Polasky, and Adams 2000). This research systematically explores the amenity value of wetlands to nearby single family residents to understand how wetland amenity values are influenced by wetland characteristics and conditions, levels of private access to wetlands, and ambient levels of wetland amenity in a neighborhood.

As mentioned above, prior studies have discussed the effects of wetland amenities on residential properties, but it is unclear about why residents are willing to pay for such amenities, and how wetland amenities impact nearby single family homes. The literature indicates that wetlands provide various natural amenities such as an aesthetic resource, views, and opportunities for outdoor recreation to enhance the environment quality of

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This dissertation follows the style of *Land Economics.*

local neighborhoods and meet human beings' natural desire for good environmental quality.

Stevens, Benin and Lareson (1995) found that respondents in New England are willing to pay over 80 dollars per year for wetlands with rare species. Another survey of 1200 individuals in Staffanstorp, Southern Sweden revealed that individuals have heterogeneous preferences for wetlands' characteristics, but "biodiversity" and "walking facilities" have the highest marginal willingness to pay value (Carlsson, Frykblom, and Liljenstolpe 2003). Many hedonic studies on natural amenities have also found that home buyers are willing to pay premiums (actual dollars) for the proximity to trees, water bodies, green spaces or open spaces (Anderson and Cordell 1988; Lansford and Jones 1995; Nicholls and Crompton 2005; Crompton 2001a; 2001b; 2004; 2005; Mansfield et al. 2005).

Appreciations for natural amenities are also reflected on people's choices of housing locations. Weichhart (1983) concluded that the natural setting is one of determinants of residential choice based on a survey of residents in Salzburg, Austria. The most frequently responded items in the survey are related to quietness, clean water, close to water, forest, trees, and open-spaces.

As one of natural habitats, wetlands provide forests, open waters, and green spaces for local residents, especially for those who live close to wetlands. A few empirical studies have found that wetland proximity (i.e. distance to the nearest wetland) positively impact housing property values (Lupi et al. 1991; Doss and Taff 1996). It is easily assumed that the sales price of a house should be positively impacted by a nearby wetland. But wetlands do pose negative impacts on residential properties. For instance, some wetlands produce odors, attract insects and animal annoyances. Many residents perceive wetlands as a potential indicator of flood risk. Moreover, wetland regulations limit development opportunities of properties near or on a wetland. Guttery, Poe, and Sirmans (2004) conducted a research related to residential property owners affected by federal wetlands regulations. Their results showed that sale prices of properties located in a wetland area are discounted nearly 8%, after controlling flood prone properties.

But on the other hand, wetland regulations do preserve the condition of a wetland, and enhance a sense of community. Earnhart (2001) studied the value of wetlands in Fairfield, Connecticut. He concluded that restored wetlands increase property values, while disturbed wetlands decrease property values. Sims and Schuetz (2007; 2009) mentioned that environmental overlay zones may increase the values of existing homes by constraining the supply of additional homes within the zones. But the question of how wetland regulations impact single family home values still remain unclear in the literature.

The amenity value of wetlands to nearby residents is decided by a bundle of amenities and disamenities provided by the wetlands. Bin and Polasky (2005) argued that the question of whether wetlands generate positive or negative net values to nearby residents is an empirical investigation. This study empirically examines how wetlands impact nearby single family property values in Chatham County where the distribution of wetlands is widely different in terms of quantities, types, and sizes of wetlands.

Prior wetland amenity studies simply examined the influences of type and size of wetland, and wetland proximity on residential property values assuming that all wetlands in their study areas are equal as far as the opportunities and benefits provided to nearby residents. Investigation of subtle difference in the levels of wetland amenity across a study area will present a more sophisticated study. Synthesizing a comprehensive body of relevant literature, this study develops a set of wetland variables to estimate different levels of wetland amenity in terms of wetland characteristics and conditions, levels of private access to wetlands, and ambient levels of wetlands available in surrounding neighborhoods.

An economic approach could explain how the changes of quantities, quality, and conditions of access to environmental amenities influence the people who use the amenities (Smith 1989). The willingness to pay for environmental amenities can be expressed in term of marginal price impacts on a nearby house (Freeman 1993). Hedonic pricing model is often used to estimate the impacts of environment amenities on housing values, because its capabilities of measuring non-marketable goods and services in term of a monetary form. The method can single out the effects of environmental amenity of interest from the rest of housing attributes. This study uses actual sales prices of single family homes to estimate the amenity value of wetlands by observing how sales prices of single family properties vary as the changing levels of wetland amenity, such as increasing or decreasing proximity to wetland, changes of wetland characteristics and conditions.

Prior studies have applied hedonic models to estimate wetland amenity value to nearby residential properties. But their findings are inconsistent and hard to be interpreted. For instance, Lupi et al. (1991) found positive effects on residential property value, while Bin and Polasky (2005) found a negative relationship between residential development and wetland proximity. The inconsistence can be explained by two issues plaguing the implementation of hedonic methods:

First, it is likely that estimated results from their hedonic models are biased because of omission of relevant wetland variables in the models. As a result, the estimates of wetland attributes are sensitive to model specification. This research enhances the implementation of hedonic methods by adopting a broader approach to fully enumerate the amenity value of wetlands gained by nearby residents.

Similar to the open space amenity study conducted by Corell, Lillydahl, and Singell (1978), this research captures the amenity value of wetlands as both "a public good" to a neighborhood, and a "quasi-public good" to nearby residents. To distinguish between the "quasi-public" and "public good" benefits of wetlands, this study applies an approach developed by Walsh (2007) to estimate the amenity effects of wetlands. The approach uses two parameters: W^p and W^n. W^p defines the levels of private access to a wetland proxied by two variables: a dummy indicator describing the immediate adjacency to a wetland and a distance variable describing the spatial relationship between a given lot location to its nearest wetland. W^n measures the ambient levels of wetland amenities available in a neighborhood proxied by the number and acreage of wetlands available in the neighborhood. GIS approach is used to develop spatial measurements at both lot and neighborhood level.

Second, if wetland resources vary across study regions or even within a region, ignorance of spatial variations in types, regulation conditions, and quantities of wetlands results in inconsistent, sometime even biased estimates of wetland attributes. Cho, Poudyal, and Roberts (2008) argued that it is problematic for many hedonic studies of open space amenities didn't address the endogeneity of open space issue and assumed that the amenity effects of open space are constant across a region. Bin and Polasky

(2005) concluded that wetland amenity value depends on both the characteristics of wetlands and characteristics of a study area. They found that wetland proximity, the size of the nearest wetland, and the percentage of wetlands within a quarter mile of a property negatively relate to the property value in a rural setting. But in urban settings, Lupi et al. (1991) found that a larger size wetland more significantly increases nearby residential property values in Ramsey County, Minnesota. Mahan et al. (2000) found that both increasing the size of the nearest wetland and decreasing the distance to the nearest wetland increase house values in Oregon, Portland.

Because of the varying distribution of wetlands across Chatham County, GA, the study estimates spatial variation in the amenity value of wetlands using separate hedonic models for three sub-study areas. The three areas represent rural, urban, and suburban setting respectively. Separate hedonic models contribute to the understandings of how and to what extent wetland amenities impact single family homes across different regions, and which wetland attributes are influential in determining the amenity value of wetlands for each type of study setting.

1.2 Research Objectives

This study attempts to achieve the following research objectives:

1. To understand why, how, and to what extent wetlands impacts nearby single family home sales prices.
2. To develop new instrumental variables to differentiate the levels of wetland amenities in hedonic models.

3. To examine the impacts of wetland basic characteristics such as size and type of wetland on single family home sales prices.
4. To examine the impacts of wetland regulations such as environmental overlay zoning and wetland setback requirement on single family home sales prices.
5. To examine the impacts of different levels of private access to wetlands on housing sales price through measuring the spatial relationships between a single family home and its nearby wetlands.
6. To examine the impacts of neighborhood wetland effects (i.e. the ambient levels of wetlands available in a neighborhood) on housing sales price through measuring wetland quantities in specified neighborhoods).
7. To apply separate hedonic models to understand the spatial variation in wetland amenity value across the study region.

1.3 Significance of the Study

This research not only addresses specific limitations discussed above, but also has several implications for future environmental policy-making and wetland amenity studies. First, the findings of the study have pragmatic implications in the policies of wetland preservation and regulation. Boyer and Polasky (2004) pointed out that lack of evidence of economic benefits from wetland preservation makes it difficult for policy makers to balance economic development and environmental protection. Understanding the amenity value of wetlands to local community greatly helps policy-makers determine what kind of wetland policy is needed to protect wetlands, especially those near to residential properties. For instance, if wetland amenities positively affect housing price in the market, wetland owners or developers will be motivated to preserve wetlands, and therefore less public intervention is necessary for wetland preservation purpose (Lupi et al. 1991).

Positive amenity value of wetlands accrued to nearby residential properties also help increase property tax revenues for local government. The revenues can be used to either financially compensate the economic losses of farmers or other wetlands owners, or support private developers to maintain the quality of existing wetlands or even increase the inventory of local wetlands. However, if the amenity value of wetlands turns out to be negative, as found by Bin and Polasky (2005), strict public policies are required to prevent wetland conversion activities (Lupi et al. 1991; Reynolds and Regalado 1998).

In brief, estimating the amenity value of wetlands is essential for policy makers to make sound benefit-cost decisions regarding wetland use and regulation, and especially choose effective instruments (incentive-based vs. regulation instruments) to achieve the balance of environmental protection and economy development. In doing so, the decisions of environmental protection can also be well reasoned and supported by local communities (Doss and Taff 1996; Batie and Mabbs-Zeno 1985).

1.4 Assumptions and Delimitations

1.4.1 Assumptions

- Individuals are well informed of all alternatives and free to choose a house anywhere in an urban market.
- Housing market is in equilibrium, the sales price just clears the existing stock of housing.

1.4.2 Delimitations

- The study is limited to the wetlands documented by Nation Wetland Inventory (NWI) in U.S. Fish and Wildlife Service (USFW). The inventory is also used by Savannah-Chatham County Metropolitan Planning Commission.

1.5 Dissertation Outline

The dissertation consists of seven chapters. Chapter I introduces research problems, objectives, and methods. The importance of the research is also briefly discussed. Chapter II reviews a comprehensive body of literature including basic concepts about wetlands and housing, and empirical hedonic housing studies on the amenity and disamentiy effects of both natural and built environment. Chapter III discusses the theories and models applied to this study. Research questions and a conceptual model are presented at the end of the Chapter. Chapter IV describes research design, methods, and procedures, and finishes with the discussion of hedonic variables and measurements. Chapter V explains how research data are analyzed. An overall hedonic model is specified to understand the general impact of wetlands on housing price in the study region. Chapter VI presents three separate hedonic models to investigate how wetland amenity values vary across different sub-study areas of the study region. Chapter VII focuses on summarizing major findings and conclusions from hedonic models analyzed in Chapter V and Chapter VII. The Chapter also discusses the contributions and policy implications of the study, and points out research limitations and recommendations for future studies.

CHAPTER II

LITERATURE REVIEW

The Chapter reviews six areas of the literature. The first section discusses the concept and classification of wetlands, and their functions and values. The second section introduces the determinants of housing price. Empirical hedonic housing studies about housing structural attributes, neighborhood characteristics, wetlands, and other natural amenities such as green spaces, parks, open spaces, and forests are introduced. Hedonic theory and market segmentation theory are also briefly discussed in the Chapter.

2.1 Wetlands

2.1.1 Wetland Definitions and Classifications

Wetland is closely linked to water bodies such as oceans, rivers, lakes and streams to form marshes, bogs, swaps, fens, pocosins, and wet meadows (Cowardin et al. 1979). There is no precise and widely agreed definition of wetlands. Various definitions have been developed for wetland regulation and protection purposes (Tiner 1999). The wetlands data used in this study were collected from National Wetlands Inventory complied by U.S. Fish and Wildlife Service. The agency defines wetlands as follows:

> Wetlands are lands transitional between terrestrial and an aquatic system where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have on or more of the following three attributes: 1) at least periodically, the land support predominantly hydrohyptes; 2) the substrate is predominantly un-drained hydric soil; and 3) the substrate is non-soil and saturated with water or covered by shallow water at some time during the growing season of each year. Saturation with water is the dominant factor determining the nature of wetlands (Cowardin et al. 1979, p.11-12).

According to Cowardin et al. (1979), National Wetland Inventory of the U.S. Fish and Wildlife Service adopted a three-level classification system: level one classification includes marine, estuarine, riverine, lacustrine, and palustrine systems. Each system is further divided into subsystems: subtidal, intertidal, and others. Level three classification describes more specific characteristics such as rock bottom, unconsolidated bottom, and aquatic bed of the subsystems.

2.1.2 Wetland Functions and Values

Wetlands provide various ecological, social, and economic values, but many of the values cannot be measured by market prices. Brander et al. (2006) divided wetland functions into three categories: hydrological, biogeochemical and ecological functions, from which socio-economic benefits or values of wetlands are derived. Turner et al. (2000) developed the connections between wetlands various functions and their values. Brander et al. (2006) conceptually summarized the total economic value of wetlands, and broke it into two parts: use values and non-use values.

The total economic value of a wetland includes both market and non-market value of goods and services produced by the wetland. This study only addresses the part of nonmarket value accrued to local residential properties as environmental amenities. Some benefits or utilities associated with a nearby wetland are easily recognized by local residents. For instance, wetlands, like other natural resources, provide positive environmental amenity values for nearby residents including views, aesthetics, open spaces/green spaces, recreational opportunities such as hunting, camping, and fishing, and an exotic landscape with a sense of wildness.

But wetlands are different from green spaces or other natural resources in two aspects. First, wetlands provide more nonmarket goods and services than common green spaces. It could more effectively enhance water and air quality of local communities, provide wildlife shelters, and maintain regional ecology integrity. Second, compared to neighborhood liabilities generated by urban parks and green trails such as crimes, noises to nearby residents (Troy and Grove 2008; Netusil 2005), wetlands generate natural negative externalities such as odors, insects, and animal annoyance. The negative externalities vary extensively from open-water wetlands to forests and swamps. Furthermore, residents that live near wetlands are often prone to floods, which can lead to additional negative impacts on their property values.

The question of how to define and quantify the value of a wetland is a puzzle in wetland valuation literature, since its value is firmly rooted in immeasurable/nonmarket goods and services. Kusler (2004) suggested using four sets of wetland characteristics to define wetland functions and values. The first set describes the natural process occurring within wetlands. The second is related to the natural landscape context of wetlands. The third focuses on the impact of cultural context around wetlands, such as highways and houses. The fourth pertains to the public attitudes toward wetlands reflected in wetland conversion activities, wetland regulation and preservation programs. Following his train of thoughts, this study conceptually measures the value of wetlands from three perspectives: their individual characteristics, cultural and neighborhood context, and existing wetland regulation effects. Moreover, wetland valuation process also has to be case-specific. Woodward and Wui (2001) summarized 39 wetland valuation studies considering the relative value of different wetland services and functions, and concluded that the valuation studies are diverse in terms of both wetland characteristics, the characteristics of study areas, and the valuation methods used. They suggested that site-specific valuation efforts are necessary to precisely estimate the value of a wetland.

2.1.3 Wetland Characteristics

Wetlands are often differentiated in terms of their size, types and locations. Regardless of the type and location of a wetland, the ecological integrity of the wetland is largely decided by its size and hydrological characteristics (Dramstad, Olson, and Forman 1996; Burns and Wilson 2003). A larger wetland more easily maintains its ecological integrity than a smaller one. If a wetland is located near a stream/river or another wetland, the ecological functions of the wetland can be easily maintained due to the short hydrological connective distance to water edge and the short commute corridor to another wetland for wildlife.

However, urban development fragments a large wetland into smaller, sometimes even ecologically isolated wetlands. The process of fragmentation deteriorates wetland ecological integrity and consequently its value. Burns and Wilson (2003) developed a systematic methodology to measure the characteristics of wetland landscape using the following variables: size of wetland, habitat linkage, hydrological link, and the level of disturbance and fragmentation. However, wetland characteristics in this study are simply measured by its basic physical characteristics such as size and type due to data availability issues.

2.1.4 Wetland Valuation Methods

Environmental goods and services provided by wetlands are not directly traded in the market, and therefore have no price of using them. But the goods and services can be valued using non-market valuation models. There are two major non-market valuation methods used in prior wetlands valuation studies: revealed preference and stated preference method. Revealed preference method uses individual behaviors in an actual or surrogated market to estimate the value of an environmental good or service. The typical examples of the method are travel cost method (e.g., Ramdial 1975; Cooper and Loomis 1993) and hedonic pricing method (e.g., Lupi et al. 1991; Doss and Taff 1996). Hedonic pricing method derives values for an environmental good or service by "*using information from the market price of its close substitutes.*" (Asafu-Adjaye 2000, p.356).

The stated preference method attempts to elicit environmental values directly from surveys, such as contingent valuation method (e.g., Farber 1988; Bateman and Langford 1997). Contingent valuation and hedonic pricing methods are the most common methods used in wetlands valuation literature. Contingent valuation method estimates both use and non-use value, but hedonic pricing method cannot sufficiently capture non-use values of wetlands (Oglethorpe and Miliadou 2000). This study utilizes hedonic price models to estimate the partial use value (amenity value) of wetlands.

2.2 Housing Price Determinants and Measurement

2.2.1 Housing Is a Commodity

A house is not a homogeneous good, consisting of a bundle of attributes such as size, quality, and location. Housing price is largely determined by three categories of attributes: structural, locational, and neighborhood variables. Each house has its own unique set of attributes determining its sales price, from which a home buyer's preferences for housing characteristics are revealed.

2.2.2 Structural Variables and Property Value

Structural variables include all attributes related to the physical structure of building(s) and property itself. A house's structural attributes are the most important factors influencing the sales price of a residential property. Structural variables are often measured by lot size, square feet of living area, number of bathrooms and bedrooms, etc. In general, increasing the size of the property, the house's living area, number of bathrooms and bedrooms increase housing sales price, while increasing building age negatively impacts the sales price (Sirmans et al. 2005).

2.2.3 Locational Variables and Property Value

Locational variables are intangible but important enough to influence a homebuyer's residence decision, because the amenities associated the residence location significantly impact his or her future life quality. The sign of effects depend on whether the amenities impose costs or benefits to the home owner (Orford 1999). Locational variables are often measured by the distance or travel time from a housing unit to various amenities. Using GIS tools, Euclidean distances from the centeriod of each single family residential parcel to its nearest amenity features such as highways, historic districts, parks, or wetlands are measured in this study to estimate the impacts of the locational amenities on housing price.

2.2.4 Neighborhood Variables and Property Value

Houses vary in terms of their physical characteristics and locations, but also in their neighborhood characteristics. It is natural that people sharing similar socio-economic characteristics tend to live in the same neighborhoods. Neighborhood characteristics refer to the socio-economic characteristics of a neighborhood such as median household incomes, ethnic composition, school quality, and residential density. Harris (1999) concluded that socio-economic and racial compositions of a neighborhood significantly impact housing prices in the neighborhood. School quality and zoning characters also have impacts on housing price (Winger 1973; Bogart and Cromwell 1997; Kane, Riegg, and Staiger 2006; Gibbons and Machin 2008; Mark and Goldberg 1986; Glaeser and Gyourko 2002).

Despite the importance of neighborhood characteristics, not many studies have examined the impact of neighborhood characteristics on property values due to the fact that accurate neighborhood characteristics and household characteristics data are difficult and expensive to collect. U.S. Census data are often used to describe neighborhood socio-economic characteristics (Morland et al. 2002; Lee and Cubbin 2002; Frank, Andresen, and Schmid 2004; Kinra, Nelder, and Lewendon 2000). But Census data cannot be used to describe individual household characteristics because the data are aggregative at block-group level. Therefore only a few variables are considered in this study to measure some characteristics of a neighborhood such as school district and zoning characters.

2.3 Natural Amenity Effects and Property Value

Due to limited studies in examining the impacts of wetlands on housing price in the literature, this study draws upon other relevant studies to understand how wetlands impact nearby property values. Many natural amenity studies related to green spaces and open spaces are reviewed in the Section, because wetlands have some similar utilities as open spaces/green spaces to nearby residents, such as providing a natural or semi-natural environment. The literature review helps identify potential methods and variables to fully enumerate the amenity value of wetlands accrued to nearby residents.

2.3.1 Green Spaces and Property Value

Many empirical studies have found that proximity to green spaces would increase residential property values (Nicholls and Crompton 2005; Crompton 2001a; 2001b; Mansfield et al. 2005; More, Stevens, and Allen 1988). Espey and Owusu-Edusei (2001) estimated the effect of proximity to different types of parks on housing prices using a data set of single family homes in Greenville, South Carolina. They found positive spillover effects within 1500 feet of attractive parks with a medium size. The prices of houses with closer proximity to parks are 13% higher than those located relatively further away from the parks. Crompton (2005) surveyed over the past two decades' empirical evidence about the amenity value of parks in U.S., and concluded that a park could possibly enhance adjacent property values by 20%. He suggested that parks and open spaces are the highest and best uses of lands in term of their effectiveness of cutting infrastructure costs from new development.

2.3.2 Open Spaces and Property Value

Open spaces generally have a positive relationship with surrounding housing values. For instance, proximity to a golf course has a significant impact on the prices of nearby residential properties (Do and Grudnitski 1995; Lutzenhiser and Netusil 2001). Lutzenhiser and Netusil's study further found that the sales prices of properties within 200 feet of a golf course are positively related to close proximity to the golf course, but the prices decline very quickly as the distance to the golf course increases.

Geoghegan, Wainger, and Bockstael (1997) examined the effects of agricultural and forested lands on the value of residential land in an exurban region of central Maryland. They found that increasing proportion of open spaces within a 100m of a residential land increases the land price, while increasing proportion of open spaces within one kilometer buffer of the land decreases its price.

Cheshire and Sheppard (1995) estimated the question of how publicly and privately held open spaces impact on residential property values differently using separate datasets from two medium sized towns in England. They found that their results are highly related to the characteristics of the two towns, more specifically, the amount of open space resources available in the two towns. Irwin and Bockstael (2001) estimated how the effects of developable open spaces differentiate from those of permanent preserved open spaces, and found that both types of privately hold open spaces generate positive and significant spillover effects. Geoghegan (2002) also examined the effects of developable vs. permanent open spaces. But he found that permanently preserved open spaces are much more valuable than developable open spaces. Irwin (2002) further argued that open spaces are valued for providing an absence of development, rather than an amenity to nearby residents using residential sales data from the central region of Maryland.

2.3.3 Wetlands and Property Value

Prior studies have examined the economic value of wetlands to nearby residents using types, size of wetland, and proximity to wetlands. Lupi et al. (1991) found that a large size wetland has positive effects on nearby residential properties in Ramsey County, Minnesota. Doss and Taff (1996) argued that residents prefer scrub–scrub and open-water wetlands over forested and emergent vegetated wetlands. Mahan et al. (2000) found that both increasing the size of the nearest wetland and decreasing the distance to the wetland increase house prices in Portland, Oregon, but types of wetland (i.e. open water, forest and grassland) have no influence on the prices. Earnhart (2001) studied the amenity value of wetlands in Fairfield, Connecticut, and concluded that restored wetlands increase property values, but disturbed wetlands decrease property values.

The four studies discussed above estimated the value of wetlands in urban settings. In rural settings, Reynolds and Regalado (1998) found that wooded and emergent vegetation wetlands have negative impacts on property values, while open-water and scrub-scrub wetlands have positive impacts on the values. One recent study conducted by Bin and Polasky (2005) found that the impacts of wetlands on housing prices depend on both the types of wetland and housing markets. Wetlands in rural areas have less amenity value than urban wetlands to nearby property owners. Wetlands dominated by forest and shrub vegetation in rural areas often generate negative externalities, while open-water wetlands likely generate positive amenity value in either type of setting. Walsh, Soranno, and Rutledge (2003) examined the impacts of residential land use on wetlands, and found that within 300 m of wetlands, residential land uses are negatively associated with wetland land uses. The mixed results from prior studies indicate that wetlands generate both benefits and costs to nearby residents depending on the characteristics of wetlands (e.g. type and size of the wetlands), and study settings (urban vs. rural).

2.3.4 Flood Risk and Property Value

Wetlands are often located along or within floodplains near to open waters, which can lead to a negative impact on nearby residential properties. Bin and Polasky (2006) argued that the negative impact of wetlands is largely associated with the risk of floods involved. Their earlier study (2004) and Shultz and Fridgen (2001) confirmed the negative impacts of floodplains on housing values. However, the finding is further complicated by the specific characteristics of wetlands. Coastal wetlands involve a high risk of flood and a strong coast-front amenity effect as well. Home buyers are willing to pay for high premiums for the amenities associated with costal-front properties, despite the high level of food risk involved (Bin, Kruse, and Landry 2006).

2.3.5 Summary

In summary, natural amenities have positive impacts on nearby property values in general, but the direction and magnitude of effects depend on the levels of closeness to natural amenity (adjacency vs. proximity), and the characteristics of natural amenities such as type, size, and location etc. This study not only includes the variables have been examined in the literature such as types, size of wetland, and proximity to a wetland, but also generates new variables based on relevant literature and existing data to fully enumerate the amenity value of wetlands accrued to nearby residents. See more discussions in Section 3.3 and Section 3.4 in Chapter III.

2.4 Built Environment and Property Value

The dynamic interaction between land-use and transportation development changes natural environment, and creates various elements of built environment such as residential housing, commercial buildings, supermarkets, streets, etc. (Lawrence and Low 1990). Major components of built environment are transportation systems, land uses, and buildings. The Section overviews the literature related to the impacts of transportation facilities and various other land uses on nearby property values.

2.4.1 Transportation Facilities and Property Value

Transportation facilities impact nearby property values in either a positive or negative way. Forrest, Glen and Ward (1996) found that easy access to transportation facilities increases nearby property values by decreasing transportation costs. But Williams (1991) argued that easy access to transport facilities also involves disamenity issues such as, noise, air pollution, or higher crimes to nearby properties. A few studies found that traffic and airport noises have negative impacts on nearby property values (Wilhelmsson 2000; Espey and Lopez 2000; Tomkins et al. 1998). But Gatzlaff and Smith (1993) concluded that Metrorails only weakly impact the value of residence near a station.

Ryan (1999) reviewed empirical studies about transportation facilities and property values. She argued that the inconsistent results from the literature are partially caused by the issue of accessibility measurement. He found that if researchers measure access to highways using travel time, results often indicate an inverse relationship between access to highways and property values. But if studies use travel distance to measure the level of access to transportation facilities, results tend to show mixed amenity effects.

2.4.2 Land Uses and Property Value

Boyle and Kiel (2001) summarized the literature about the impacts of undesirable sites such as industry, super funds, landfills, refineries, toxic or waste sites, incinerators, power plant on nearby property values. They concluded that undesirable land uses have negative impacts on housing values, but desirable land uses such as parks, golf courses trails, greenbelts, cemeteries, agriculture, and forested land often positively impact nearby property values (Lutzenhiser and Netusil 2001; Nicholls and Crompton 2005; Crompton 2001a; 2001b; Geoghegan et al. 1997; Do and Grudnitski 1995).

2.4.3 Summary

A survey of relevant literature suggests that the amenity value of wetlands depends largely on wetland characteristics such as its size and types, and levels of access to a wetland (adjacency to vs. proximity to a wetland). However, other relevant literature also indicates that factors such as wetland conditions and regulations, neighborhood amenity levels, flood risk, structural characteristics, neighborhood characters, locational amenities, and the characteristics of study areas also significantly impact housing price, and therefore should be considered in the wetland amenity valuation study.

2.5 Hedonic Theory

2.5.1 Hedonic Theory and Its Assumptions

Rosen (1974) suggested that products' characteristics could be used to estimate the value of a complex product. He defined hedonic prices as "*the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them*" (Rosen 1974, p. 34).

In a housing market, hedonic theory assumes that consumers derive the utility of environmental amenity not from the consumption of a good directly, but rather from the consumption of the characteristics contained in a good. The hedonic function is written as follows:

$$U = U(X, Q, S, N) \qquad [2\text{-}1]$$

Where X is a person's consumption of a composite commodity, Q is a vector of location-specific environmental amenities, S is a vector of structural characteristics of the house, such as lot size, number of rooms, age, and construction quality, N is a vector of characteristics of the neighborhood where the house is located, such as quality of local schools and residential density.

Freeman (1979) summarized three underlying assumptions of hedonic price models. First, an urban area is viewed as a single market. Second, individuals must be well-informed and free to choose all housing substitutes anywhere in the urban market. Third, the housing market is in equilibrium. All home buyers make their utility–maximizing residential choices given alternative housing locations. They pay a housing price that just clears the market given the existing stock of this type of housing and its characteristics. Buyers are more concerned about the price of housing characteristics than the supply side of the market.

2.5.2 Hedonic Basic Model

Under the three assumptions, the price of a house can be described as a function of the structural, neighborhood, and environmental characteristics of the house:

$$P = P\ (S, N, Q) \qquad [2\text{-}2]$$

The relationship between the house price and its various attributes could also be described as:

$$\mathbf{P} = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e \qquad [2\text{-}3]$$

Where P is a vector of observed property values, α is a vector of regression intercepts, X_1 is a vector of structural attributes, X_2 is a vector of neighborhood attributes, X_3 is a vector of location attributes, β is a vector of correspondent regression coefficients, and e is a vector of random errors.

Hedonic models assume that consumers implicitly buy environmental goods when purchasing a marketed good. For example, when a house is purchased, the buyer receives the house, its neighborhood characteristics, and locational and environmental amenities. By regressing the characteristics of the purchased house such as structural, neighborhood, location attributes the contribution of an environmental amenity to explaining the price of the house could be extracted from the models.

2.5.3 Hedonic Price Model's Limitations

A hedonic property model has two attractive features. First, it uses real property market data to estimate the value of environmental amenities in a monetary term. Property markets are relatively efficient in responding to information, so can be good indications of value. Second, the model can be used to estimate values based on individuals' actual choices of house. The model could capture the amenity value of environmental amenities by controlling the effects of other housing attributes on housing price.

But it has several limitations: it assumes individuals freely select housing characteristics purely based on their preferences, and does not consider the supply constraint of such choices. Second, it only captures the use-value of an environmental amenity, but ignores non-use value of the amenity. Third, the amenity value of wetlands measured by hedonic models is limited to the portion accrued to nearby properties. But wetlands provide many more services to the society such as wildlife shelters, ground water recharge and discharge. But people are often not well aware of the values of these services and the linkages between such environmental amenities of wetlands to them or their properties. Mahan et al. (2000) argued that hedonic property price method measures only the amenity value of proximity to wetlands perceived by property owners or single family home purchasers. Therefore, the amenity value of wetlands examined captures only a subset of wetland values accrued to nearby properties, not the total economic value of wetlands.

2.6 Market Segmentation

A typical problematic assumption about open space hedonic study is: open space amenity effects are constant across a study region (Cho et al. 2008). Spatial variation in the amenity effects should be appropriately investigated since the distribution of open spaces very often varies across the region. Furthermore, a metropolitan's housing market in nature is heterogeneous due to the varying spatial locations of housing stock and homebuyers' preferences. This section provides a brief review of housing market segmentation theory.

Submarket segmentation theory assumes that a metropolitan's housing market consists of a set of differentiated submarkets. The houses in a submarket are close substitutes within the submarket but poor substitutes in other submarkets (Grigsby et al. 1987; Bourassa et al. 1999). For instance, buyers who prefer to live in Savannah only consider those substitute properties in Savannah, not other areas in Chatham County.

Straszheim (1974) first analyzed a metropolitan area's housing market as a set of different submarkets based on municipal boundaries, racial composition, and other housing characteristics. He applied hedonic price model for each submarket separately, and found substantial spatial variations in term of implicit prices of many housing attributes, and a significant reduction in the sum of squared errors. Michaels and Smith (1990) concluded that a single hedonic price function is not appropriate for the Boston housing market due to the fact that 15 of the 21 coefficient estimates are significantly different across four submarkets. Bourassa et al. (1999) suggested that if the accurate estimation of coefficients for each submarket is concerned, and when market segmentation does exist, separate hedonic price models can generate more accurate estimates of housing attributes for each submarket. Due to the uneven spatial distribution of wetland resources across the sub-regions of the study area, this study is directed toward identifying the spatial variation in both the amenity value of wetlands and the implicit prices of wetland attributes across the study area using separate hedonic models.

CHAPTER III

THEORIES, MODELS, AND HYPOTHESES

The price of a house is primarily determined by two factors: its location and the physical structure attached to the house. The competitiveness of a location depends primarily on how well amenities associated with the location meet a housing purchaser's needs, and the overall supply of such housing locations (amenities) in the market. Therefore, housing price conveys the information about a home purchaser' preferences and his willingness to pay for an environmental amenity.

But the question of how to value and measure a non-marketable environmental amenity remains implicit in the literature. Environmental amenity valuation theory, derived from Utility theory, suggests that the parameter of environment amenity 'q' described in the utility function 3-1 can be estimated by the amenity's qualitative and quantitative characteristics. But relevant wetland amenity studies have little discussion about how the amenity level of wetlands 'q' is measured and estimated in hedonic models. Drawing upon a comprehensive body of literature, this study conceptualizes the amenity value of wetlands from three perspectives: a wetland's own physical characteristics and conditions, levels of private access to wetlands, and ambient levels of wetland amenities available in surrounding neighborhoods.

Physical characteristics and conditions of a wetland are described by size, types of wetland, and regulated wetlands vs. unregulated wetlands. Levels of private access to wetlands, or 'wetland accessibility' generally named in this study, are decided by the spatial location of a single family residence relative to wetlands (adjacency vs. proximity to wetland). Wetland adjacency has a higher level of private access than wetland proximity, which indicates that a single family home has a direct view of or access to wetlands. The level of private access to wetlands decreases as distance to nearest wetland (i.e. wetland proximity) increases. Number and acreage of wetlands within specified buffer zones describe the ambient levels of wetland amenities available in surrounding neighborhoods.

3.1 Residential Locational Theories

Earlier theories explain the initial pricing pattern of residential location. Alonso (1964) proposed the earliest theory about residential location. He pointed out the tradeoff between commuting time and housing price: houses built at locations with shorter commutes are more expensive than those with longer commutes. Muth (1969) further incorporated the supply side of housing market into the theory, and asserted that the increasing demand for overpriced locations with shorter commutes encourage developers provide more housing substitutes at less expensive locations with longer commute but more additional amenities and services. Fulcher (2003) concluded that an ideal residential location is where the marginal utility losses from longer commutes are balanced by the marginal utility gains from the additional services and amenities.

The theories above were developed based on the assumption that a mono-centric urban land use model with jobs concentrated in the central business district of a city. But under a modern and multi-centered urban land use model, many scholars suggested that commuting distance should be no longer the only factor influencing housing price. Papageorgiou (1976) first introduced multi-centric spatial structures into residential location theory, and pointed out that environmental attractiveness, good housing quality, and social prestige of neighborhoods also play significant roles in deciding housing price. Wheaton (1977) emphasized the importance of neighborhood characters in residential location decisions. Richardson (1977) discussed the effects of public goods and externalities on residential location choices. He argued that an optimal residential location could be distant from central city congestion, and closer to high quality environmental amenities. Dipasquale and Wheaton (1994) argued that neighborhood quality and environmental amenities can account for more than half of the overall value of a house.

Chatham-Savannah County is a metropolitan area with a multi-centered land-use model and a variety of wetland resources. An intriguing research question is how wetland amenities impact nearby housing price in the area. Such research can contributes to the understanding of residential location theories by estimating to what extent wetland amenities impact housing sales prices in a housing market where supply of environmental amenities is sufficient, after controlling the effects of other housing attributes and amenities.

3.2 Environmental Amenity Valuation Theory

Estimating the value of wetland amenities requires the use of nonmarket environmental amenity valuation techniques, because the amenity value of wetlands is not directly traded in a market, but implicitly reflected in housing products attaching the amenity. This Section introduces the theory of environmental amenity valuation in the context of housing market.

Freeman (1993) explained the basic theory behind environmental amenity valuation using a utility function. Utility is used to measure the relative satisfaction from consumption of goods. Utility function describes the utility as a function of consumption of real goods. An individual's demand for environmental quality (public goods) could be expressed in term of utility function as follows:

$$u = u(X, q) \qquad [3\text{-}1]$$

Where X is a vector of private goods quantities($X = x_1 \ldots x_i \ldots x_n$), q is the parameter of environmental amenity. By entering environmental amenity as an argument in the utility function, q represents the fixed level of environmental amenity or a qualitative characteristic of the amenity.

When individuals have freedom to choose the consumption of the environmental amenity through their selection of differentiated private goods, information on environmental amenity demand or preference is embedded in the prices for the private goods (Freeman 1993). If the levels of an environmental amenity vary across spaces, individuals may choose their desired level or preferred characteristics of the amenity through their residential location decisions, such as a decision of living close to or far away a wetland.

Wetlands amenities are inherently attached to the location of a house, the amenity value of wetlands include premiums for locations with desirable wetland attributes, and discounts for undesirable ones. Demand or preference for wetland amenity is revealed by sales price differentials in housing markets. But an unsolved question is how to measure q, the parameter of environmental amenity in the Equation 3-1. Smith (1989) suggested that the quantity, quality, or conditions of access to environmental amenities decide housing market demand for the amenities, and subsequently the value of environment amenities revealed in the market. He also pointed out that environmental policy and regulations change the quantity, quality, and access conditions of environmental amenities.

Many environmental amenity valuation studies use 'quantity' measures to describe the levels of environmental amenities. For instance, Michael, Boyle, and Bouchard (1996) studied the price change of residential properties values with different levels of water quality, and found that water quality is a significant explanatory variable of residential properties. Poor, Pessagno, and Paul (2007) found that high level of water clarity leads to a positive change in property prices. Krysel et al. (2003) concluded that the estimated implicit prices of all water quality variables are significant. A meta-analysis of 37 cross-sectional studies suggests that increasing the level of air quality increases property values significantly (Smith and Hung 1995). Clay and Greenstone (2005) also found the significant impact of air quality levels on residential property values.

Similar to environmental amenities like water and air, wetlands provide a 'public good' to a community such air and water quality improvement. But it is difficult, if not impossible, to quantify the amenity value of wetlands with a single quantitative variable of q, because wetlands provide various functions and values to the society, and also spatially vary in terms of their characteristics and conditions such as types and size of wetland, and protected or unprotected wetlands. A comprehensive body of literature is drawn upon to develop a set of wetland variables to describe the parameter ‘q’ and sufficiently estimate the amenity value of wetlands accrued to nearby residents.

3.3 Wetland Amenity Value

Wetlands provide multi-function and services to the human beings. They play critical roles in supporting biodiversity and providing important ecosystem services to the society (Bolund and Hunhammar 1999; Crane and Kinzig 2005; Gaston et al. 2005; Smith et al. 2005). For instance, Bolund and Hunhammar (1999) identified wetlands as one of six natural ecosystems, and explained how people benefit from the ecosystem functions of wetlands. One of the functions is their recreational and cultural values. This research examines the recreational and cultural values of wetlands captured by nearby residential properties and revealed in the sales prices of the properties. The revealed value is called as the amenity value of wetlands, which largely reflects utilities of a wetland by nearby residents such as providing a natural setting for scenic views, aesthetics, green spaces, and outdoor spaces for recreation activities like walking, jogging, hunting, and fishing.

Diverse species and green spaces provide a ‘natural’ setting of primary contact with biodiversity for local communities. Stevens et al. (1995) found that respondents are willing to pay over 80 dollars per year for wetlands with rare species. Another survey of 1200 individuals in Staffanstorp, Southern Sweden reveals that individuals have heterogeneous preferences for wetland characteristics, but ‘biodiversity’ and ‘walking facilities’ have the highest marginal willingness to pay (WTP) value (Carlsson et al. 2003). Weichhart (1983) concluded that the natural setting is one of determinants of residential choice from a survey of residents in Salzburg, Austria. The most frequently responded items in the survey are related to quietness, clean water, close to water, forest, trees, and open spaces.

Wetland provides views of forests and open waters. The scenic views may have significant impacts on immediately adjacent property values. Sander and Polasky (2009) estimated the values of views and open spaces in Ramsey County, Minnesota, and found that increasing amount of water and grassy area in a view from the house increases the sales price of the property. But in terms of number of different types of vegetation in a view, increasing richness of vegetation in the view reduces home sales prices. Cavailhes et al. (2009) also examined the impact of landscape view to nearby residents, and found that trees and farmlands adjacent to a house positively impact its sales prices. But if the landscape view is out of sight or in the sight but more than 100-300m away, the house's sales price is dramatically lower or insignificantly impacted by the view.

Wetlands provide a natural landscape setting to nearby residents, which enhance their neighborhood overall attractiveness and consequently increase sales prices of the properties in the neighborhood. Many studies have examined the impacts of natural amenities or resources on residential values. Schulz and Waltert (2009) examined the question of how local landscape resources affect property prices. They found that proximity to natural land or easy access to green spaces significantly increases the attractiveness of a local community, and their residential property values as well. They also pointed out that the economic benefits accrued to property owners effectively improve their awareness of possible changes in the accessibility and availability of landscape resources in their neighborhood.

Relevant literature suggests that wetland amenity value may depend on both the physical conditions and characteristics of wetlands and the characteristics of the study setting. Earnhart (2001) studied the value of wetlands in Fairfield, Connecticut, and concluded that restored wetlands increase property values, but disturbed wetlands decrease property values. Geoghegan (2002) examined the effects of developable vs. permanent open spaces and found that permanently preserved open spaces are much more valuable than developable open spaces, using residential sales data from Central Maryland.

Cheshire and Sheppard (1995) estimated the question of how publicly and privately held open spaces impact on the residential property values differently using separate datasets from two medium sized towns in England. They found the study results are highly related to the characteristics of the two towns, more specifically, the amount of open space resources available in the two towns. Geoghegan et al. (1997) examined the effects of agricultural and forested lands on the value of residential land in an exurban region of central Maryland. They found that increasing proportion of open spaces within a 100m of a residential land increases the land price, while increasing proportion of open spaces within one kilometer buffer of the land decreases its price.

Prior wetland amenity studies have examined the effects of wetland basic characteristics on nearby single family home values. Lupi et al. (1991) found that a bigger size of wetlands has more significantly positive effects on the prices of residential properties in Ramsey County, Minnesota. Doss and Taff (1996) argued that residents especially prefer to live close to scrub –scrub and open water wetlands over forested wetlands and emergent vegetation wetlands. Mahan et al. (2000) also found that increasing the size of the nearest wetland increases house values in Portland, Oregon.

All the three wetland amenity studies above estimated the amenity value of wetlands in urban settings. Bin and Polasky (2005) estimated how wetlands affect residential property values in a rural setting. They found that variables such as wetland proximity, the size of nearest wetland, and wetland percentage with a quarter mile of the properties are negatively related to residential property values. The results could be related to the negative externalities generated by some type of wetlands such as forested wetlands, especially in a rural setting. As discussed in Chapter I, wetlands produce diamenities such as breeding grounds for insects, limiting productive activities like farming (Shultz and Taff 2004), and regulating property owners' development rights (Gelso, Fox, and Peterson 2007; Guttery et al. 2004). Bin and Polasky (2005) argued that the question of whether wetlands generate positive or negative net benefits for nearby residents is an empirical study, depending on the characteristics of both wetlands and the study area.

This study estimates the value of wetland amenities and disamenities in Chatham County, GA and its three sub-study areas respectively representing rural, urban, and suburban setting to understand how the amenity value of wetlands varies across the study area using a hedonic approach. The approach uses real sales prices of properties to observe how the market values of single family homes change as the amenity level of wetland amenity (q) changes.

3.4 Wetland Amenity Variables

Not like many empirical environment amenity valuation studies related to water and air condition, parameter ‘q’ is measured by a single variable or a few quantitative variables. Wetland amenity ‘q’ is measured by a bundle of both quantitative and qualitative wetland attributes suggested by relevant literature.

Prior wetland amenity studies have suggested that qualitative characteristics such as types, size of wetland, and wetland regulation factors can be used to estimate the amenity value of wetlands. Lupi et al. (1991) found that a bigger size of the nearest wetland has more significantly positive effects on the prices of residential properties in Ramsey County, Minnesota. Doss and Taff (1996) argued that residents especially prefer to live close to scrub –scrub and open water wetlands over forested wetlands and emergent vegetation wetlands. Guttery et al. (2004) conducted a research related to residential property owners affected by federal wetlands regulation. Their results indicated that sales prices of properties located in a wetland area are discounted by nearly eight percent.

In addition to size, types of wetlands, and the existing of wetland regulations, proximity to wetlands is also measured in prior studies. Mahan et al. (2000) found that decreasing the distance to the nearest wetland increases house values in Portland. But wetland proximity (i.e. the distance to the nearest wetland) alone can not solely describe the complexity of the spatial relationships between wetlands and single family parcels and consequently the levels of access to wetlands.

Early efforts to characterize the amenity effects of open spaces further enlighten how the level of wetland amenities could be quantitatively measured. As Walsh (2003;

2007) summarized the development of open space amenity studies, Weicher and Zerbst (1973) measured the amenity impacts of neighborhood parks in Columbus, Ohio using a set of dummy variables which describe immediate adjacency to protected open spaces. Corell et al. (1978) estimated the effects of protected open space amenities by including distance variables. They found that increasing one foot walking distance to protected open spaces decreases $4.20 in expected housing price. The development of GIS technology makes it possible for many open space amenity studies to measure different aggregations at a variety of scales. Geoghegan et al. (1997) estimated the impact of Maryland's Patuxent watershed on residential properties, and found that increasing percentage of open space within 100m radius of each house increases its sales price, but the percentage of open space within 1000m radius decreases the price. The most recent study by Tapsuwan, Ingram, and Brennan (2009) concluded that decreasing the distance to the nearest wetland by 1m increases the property sales price by AU$42.40; that increasing number of wetlands within 1.5km of a property is positively related to the property' sales price.

Based on the discussions above, the easy access to wetlands and the amount of provision of wetlands in a neighborhood could be another two factors influencing the economic benefits from living close to wetlands. The factors directly impact how people use and value wetland amenities. Investigation of more subtle difference in the levels of wetland amenity will represent a more sophisticated study. New wetland variables are explored based on the following reasons:

First, inherent spatial relationships between single family homes and wetlands decide how and to what level single family home owners benefit from nearby wetlands.

For instance, homes adjacent to wetlands have a direct view of wetland, but other homes can only walk over to a wetland to enjoy the amenity. One-quarter to one-half mile is defined as a distance that most people are willing to walk in five to ten minutes. Hoehner et al. (2005) defined Savannah, GA as a walkable city, and conducted a telephone survey of 1068 residents within 400 m buffer of recreation facilities in Savannah, and found that most of residents are willing to walk about five minutes to access recreation facilities including parks. They also found that people who live closer to a park or green trails use the facilities more frequently, on average, than people who live farther from the facilities.

Second, the uneven spatial distribution of wetlands leads to the varying amenity levels of wetlands cross a study area. Cho et al. (2008) argued that it is problematic for many hedonic studies of open space amenities didn’t address the endogeneity of open space issue and assumed that the effects of open space are constant across a housing market. The distribution of wetlands is extremely uneven in Chatham County, GA. Compared to east Chatham County, west Chatham County is characterized by less wetland areas and highly fragmented wetlands. Such spatial variation directly leads to the result that some property owners can access to none or a few wetland patches, while others have many wetlands available to access to in their neighborhood. Netusil (2005) argued that a property’s sales price partially depends on amenities on the property and amenities available in its surrounding neighborhoods. He defined neighborhood amenity effects at the following levels: 1) immediate neighborhood defined by one block (200ft) of the property; 2) the area between 200ft and one-quarter mile of the property; and 3) the larger neighborhood defined as the area between one-quarter mile and one-half mile of the property. The study adopts the approach to differentiate neighborhood amenity effects at different scales.

Third, open space amenity studies suggest that amenity level of wetland ‘q’ should be measured from two conceptual aspects: public good and quasi-public good of wetlands. Corell et al. (1978) analyzed the effects of protected open spaces as both “a public good” to local communities and a “quasi-public good” to nearby residents. The quasi-public good of open space is measured by the distance from a residential parcel to a protected open space. The public good part is measured by the percentage of open spaces in a given residential lot’s neighborhood.

To distinguish the two aspects of open spaces, Walsh (2007) clearly defined two parameters to measure the amenity effects of open spaces: O^p and O^n. O^p is defined to represent the level of private access to open space and is proxied by the distance from a residential location to the nearest parcel of open space. O^n measures the ambient level of open space amenities available in a neighborhood, and is proxied by the percentage of open spaces available in the neighborhood.

Synthesizing all the discussions above, this study develops three construct instruments to estimate the amenity value of wetlands: 1) wetland characteristics and conditions, 2) levels of private access to wetland, and 3) ambient levels of wetland amenities available in surrounding neighborhoods, briefly named as ‘neighborhood wetland effects’ in this study. A conceptual model is illustrated in Figure 3-1. Several research questions are summarized and presented in Section 3.5. Hedonic pricing method is used to estimate the impacts of multiple wetland amenity variables on house sales prices, while controlling other housing attributes constant.

3.5 Research Questions

Research question I: the physical characteristics and conditions of a wetland significantly impact nearby single family home sales prices.

- *Sub-question 1-1: do different types of wetland impact the prices differently?*
- *Sub-question 1-2: does a larger size of the nearest wetland increase the prices?*
- *Sub-question 1-3: how does wetland setback requirement impact the prices?*
- *Sub-question 1-4: how does environmental overlay zone impact the prices?*

Research question II: the level of private access to wetlands significantly impacts the sales prices of single family homes.

- *Sub-question 2-1: how does adjacency to a wetland impact the prices?*
- *Sub-question 2-2: how does wetland proximity (i.e. distance to the nearest wetland) impact the prices?*

Research question III: the ambient levels of wetland amenity (i.e. number and acreage of wetlands in surrounding neighborhoods) significantly impact housing sales prices?

- *Sub-question 3-1: does increasing number of wetlands available in surrounding neighborhoods increase the housing prices?*
- *Sub-question 3-2: does increasing the acreage of wetlands available in surrounding neighborhoods increase the housing prices?*

Research question IV: the spatial distribution of wetlands significantly impacts the amenity values of wetlands across the study area?

- *Sub-question 4-1: does the amenity value of wetlands vary across different study settings?*
- *Sub-question 4-2: if yes, how does the amenity value of wetlands vary?*

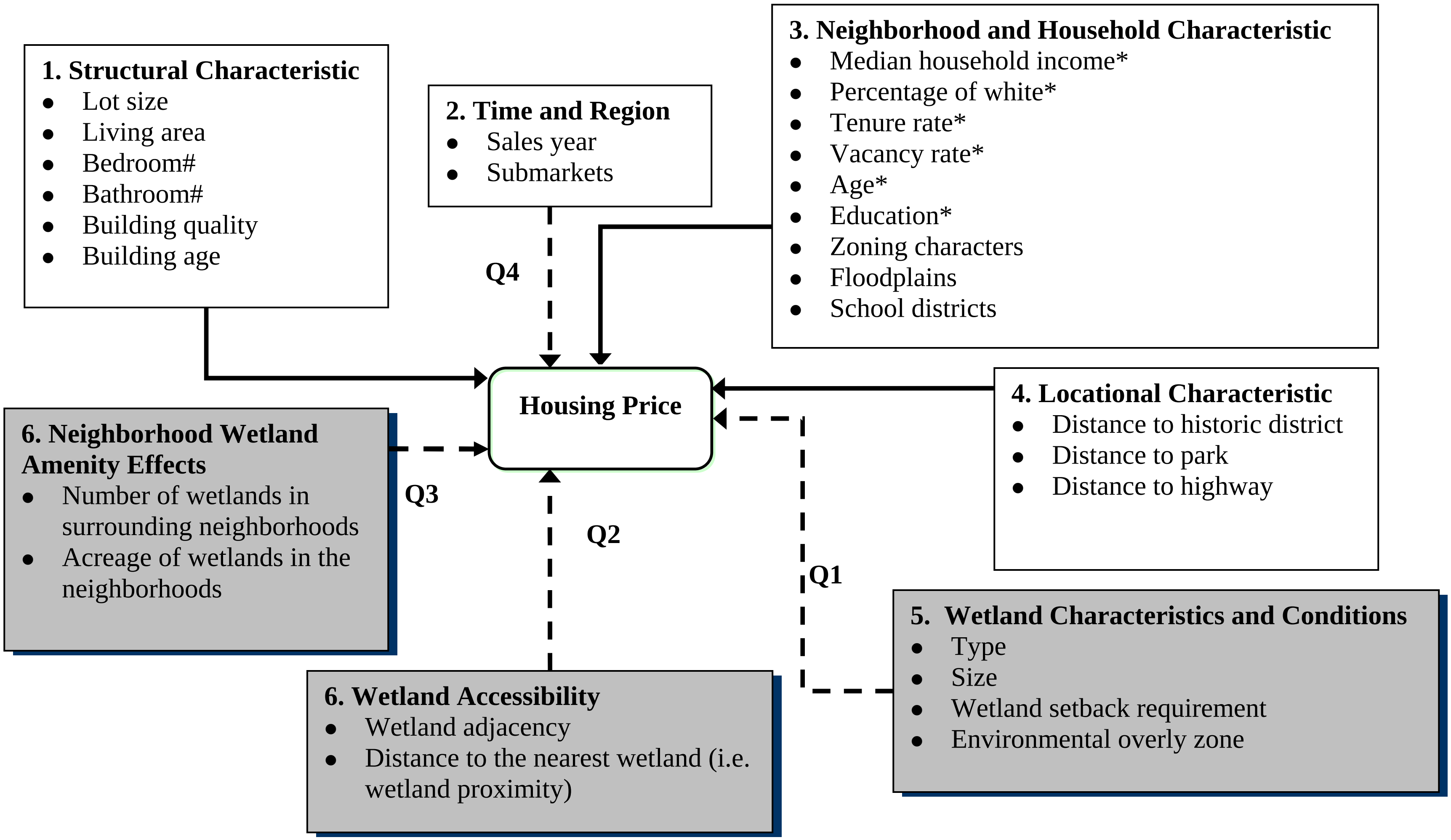

Figure 3-1 Conceptual Model

Note: variables marked by an asterisk (*) are not measured in the study due to the issue of data availability.

CHAPTER IV

METHODS AND DATA

4.1 Study Design

This study is an empirical case study integrating quantitative data analysis. It systematically and quantitatively investigates how wetlands impact nearby single family home values to expand the existing body of knowledge. A case study is often criticized for offering no grounds for establishing generality of findings. But this study strengthens statistical validity of research findings and conclusions by analyzing a large quantity of real sales data. The final results not only provide a knowledge base for developing effective wetland policies and regulations to preserve wetland resources, but also enhance local community' awareness of wetland amenity value.

4.2 Study Area

Chatham County is chosen as the study area of this research because: 1) it is one of steadily growing metropolitan regions rich in wetlands resources; 2) single family homes sales data are available; and 3) it consists of a sprawling low-density development in rural-urban interfaces where most of wetlands are clustered, but have a compact high-density urban-core area with few wetlands. Such distribution of wetlands helps deeply understand the spatial variation in the amenity value of wetlands across the study area.

Three sub-study areas are selected based on the distributions of socio-economic characteristics and wetland characteristics in Chatham County discussed below. The three study areas are City of Savannah, East Chatham County (unincorporated area), and City of Pooler. The three areas are representative in terms of population concentration, education level, development patterns, and wetland characteristics. For example, most of black, low income and poorly educated population live in City of Savannah and City of Pooler, while more white and high income and well educated population in east Chatham County. What further differentiate City of Savannah and City of Pooler are: 1) City of Savannah is the central business district area and job center of Chatham County, and further famous for its traditional urban design pattern and several nationally designated historic districts; and 2) few wetlands are located in City of Savannah, while relatively more and fragmented wetlands located in City of Pooler.

4.2.1 Geographic Location

Chatham County is located on the southeast coastal plains of Georgia, at the mouth of the Savannah River, as shown in Figure 4-1. The map shows seven municipalities and an unincorporated area within the County. The seven municipalities are Savannah, Bloomingdale, Garden City, Pooler, Port Wentworth, Tybee, and Vernonburg. Chatham County serves as an economic, cultural, and governmental hub at regional level. Early high growth rates occurred from unincorporated area to the east of Savannah where most wetlands are located, but recent development moves to the western areas of the County where many small and isolated wetlands are located (see the Figure 4-1).

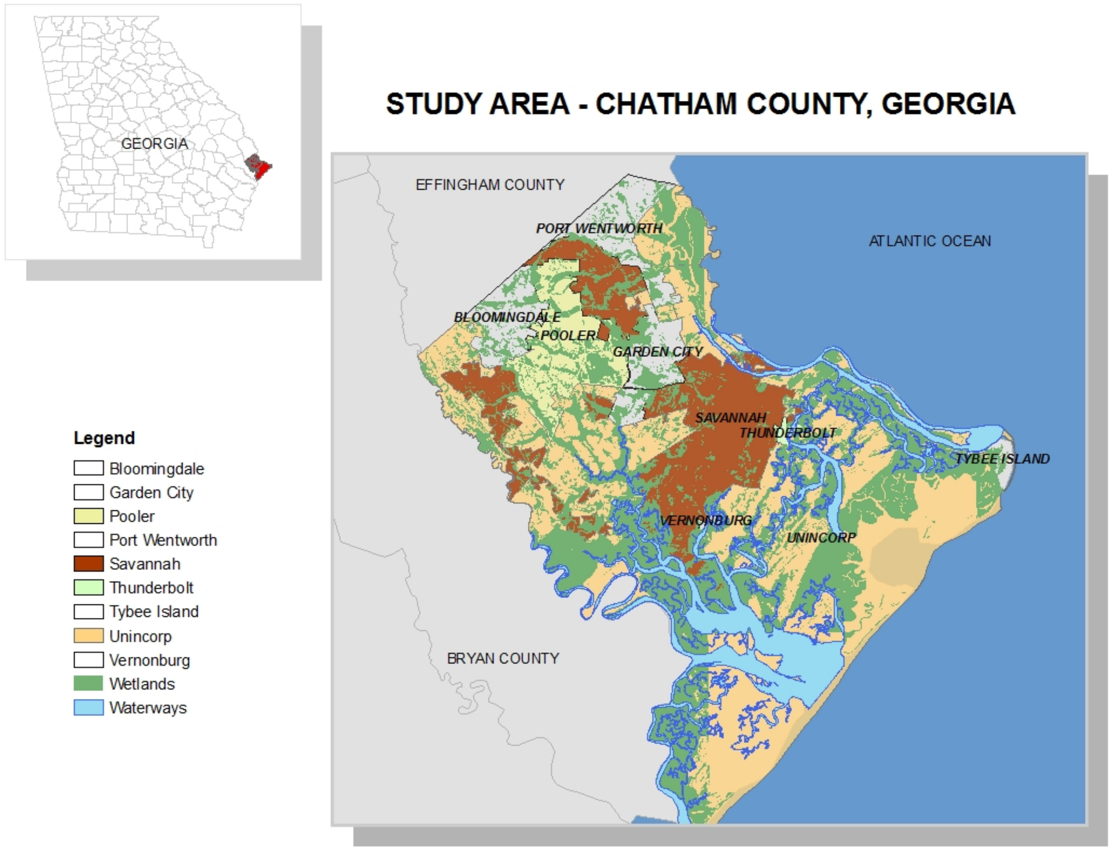

Figure 4-1 Study Area

4.2.2 Demographics

Chatham County has been experiencing stable population increase since 1950s. The distribution of the population is uneven among different regions and municipalities in the County. According to 2000 Census data from Census Bureau and 2005 estimated population by Chatham County Metropolitan Planning Commission, two most populous areas are Savannah and Unincorporated area. In 1999, forty one percent of the population of Chatham County was black. Eighty percent of the black were living in Savannah. White population comprised 54.2% of the total population of Chatham County, clustering in Savannah and unincorporated area. The black population increased more rapidly than the white population since 1980.

In 1999, the education level of Chatham County was averagely low. Only 20.9% of the total population of the County held bachelor or higher degree. The total number of households of the County in 1999 was 89,863 with an average household size of 2.5. Its median household income was $37,752 in 1999. The higher median income households (>$750,000) were mostly clustered in areas such as unincorporated area and Pooler. The lower median income households were concentrated in Savannah with high percentage of black population.

4.2.3 Economy and Housing Market

Chatham County's economy experienced a steady growth over the past 20 years, the unemployment rate continuously dropped to 3.8% in 2007. The leading industries are agriculture, forestry, fishing, hunting, construction, and manufacturing. 2000 Census data revealed that Chatham County serves as a regional job center. About 78.1% of workers in Chatham County lived and worked in the County; nearly 21.9% of the workforce worked in the County, but lived in another County.

Chatham County has two major housing submarkets: unincorporated area and Savannah. The housing stock of Chatham County metropolitan area includes a mix of single family, multi-family, and manufactured homes. As Figure 4-2 shows, single family home is the prevalent housing type in Chatham County, especially in the unincorporated area. The occupancy rate of the County's single family homes was 90% in 1999. The owner occupancy rate in the County had remained fairly stable over the last two decade.

77 percent of housing units were owner occupied in the unincorporated area, compared to 50% in Savannah. Approximately 62% of the housing stock in Savannah was at least 30 years old, and 27% housing units were over 50 years old.

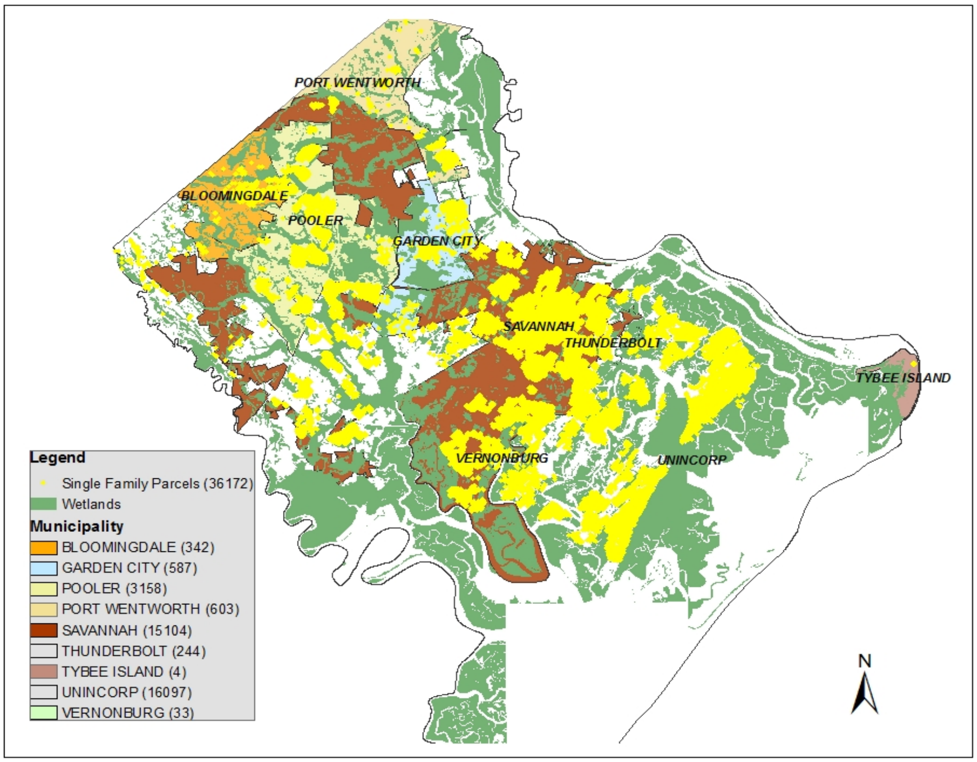

Figure 4-2 Chatham County Land-use Map

Chatham County not only provides various types of housing units with a wide variety of price ranges and sizes. These housing units are also characterized by their unique cultural and environmental amenities. Chatham-Savannah metropolitan area is widely renowned as a model for historic preservation because of its history of ‘planned city'. Five historic districts have been established in the past. The County is also diverse in geography: from countryside to salt water marshes, river ways, and balmy and sun drenched Atlantic beaches. Such diversity is further reflected in real estate market, ranging from restored 18^{th} Century townhomes, beachfront cottages, golf course lots, to secluded marsh-view hideaways. Recently second homes and retirement homes became the two fastest growing housing market segments in Chatham County, especially in unincorporated area.

4.2.4 Urban Development and Land Use

Due to square-mile blocks designed by James Oglethorpe in 1773, Savannah-Chatham County is characterized by its highly mixed-use and planned united development communities. Chatham County development is divided into several planning areas: west Chatham, Savannah, east Chatham, and other municipalities. Savannah is characterized by its high density of urban neighborhoods and historic downtown. East Chatham like unincorporated area is characterized by suburban neighborhoods settings amid wetland marshes and tidal creeks. West Chatham like Pooler and other municipalities are typically rural-suburban area characterized by many agricultural, forested, and undeveloped lands. This study selects three sub-study areas in Chatham County: Savannah, Pooler, and unincorporated area to understand the spatial variation of the amenity value of wetlands across the study region. The three sub-areas represent urban, rural, and suburban setting respectively.

In Chatham County, approximately 43% of the total area of 522 square miles is open-water, creeks or tidal marsh, 24% developed or developing land area, 20%

agricultural or undeveloped land, and 13% protected green space. Marsh wetlands are mostly located in the coastal area such as unincorporated area, while other types of wetlands such as forest wetlands are clustered located in west Chatham such as Pooler. One of research questions in the study attempts to investigate how different types of wetlands impact nearby housing prices differently across the study region.

4.2.5 Wetland Regulations and Policies

Federal government issued Clean Water Act Section 401 in 1972 to protect wetlands from development. The act has become the fundamental rule of state wetland regulations. Georgia is one of few states passed state marshlands protection act in 1970 to control the development of coastal areas. Georgia has taken four major wetland protection actions to preserve wetlands: 1) adoption of a management program for coastal marshes; 2) acquisition of wetlands; 3) designation of wetland and stream corridors as “vital areas” of the state; and 4) provision of property tax incentives (Kundell et al. 1988). Georgia Department of Natural Resources was designated to issue permits for any activities altering saltwater and brackish wetlands and the freshwater marshes intimately connected to them.

Wetland regulation is often combined with zoning ordinance to provide comprehensive wetland protection. For example, Chatham County wetland assessment in zoning ordinance requires the proposed activity is not located within a wetland area or within 100 feet of the wetland area. Both floodplains subdivision plan and planned unit development codes require dedication and permanent preservation of wetlands by promoting cluster development on upland sites or environmental sensitive locations.

Additionally, some community plans have established an environmental overlay district with supplemental standards to preserve community characters and its environment quality, especially in the coastal area of Chatham County.

4.3 Data Sources and Quality

The data of the research were collected from various sources: 1) building characteristics and last sales price data for single family homes were obtained from the sales records of Chatham County's Board of Assessor; 2) GIS data such as parcels, floodplains, zoning, school districts, wetlands, and parks were collected from Chatham County Metropolitan Planning Council published in 2007; and 3) wetland data were acquired from National Wetland Inventory, U.S. Fish and Wildlife Service.

4.3.1 Chatham County Board of Assessor

Housing prices can be obtained from three different secondary sources: self-reported home values by census block from the Census, sale prices from multiple listing service (MLS), and the appraised/market value from a county appraisal district. The housing prices collected from census cannot represent individual properties, because they were collected at block-group or above level. The sale prices acquired from MLS are costly, but the data more accurately represent the most recent actual market values. Given the large quantity of single family homes analyzed in the study, the cost of MLS data would be prohibitively expensive. This study collected property sales data from Chatham County Board of Assessor. The database describes property information such as property identification number (PIN), property owner name and address, property address, property assessed value, last sales price, the sales date, number of bedrooms and bathrooms, building use, and building quality information. 12,375 single family properties sales records were collected from the source.

4.3.2 Chatham County Metropolitan Planning Council

GIS layers (e.g. parcels, parks, road network, zoning, school districts) were collected from Chatham County Metropolitan Planning Council. Various attributes were collected from the layers' attribute tables to describe neighborhood and locational characteristics such as zoning, floodplains, school districts, historic districts, highways, and parks. In addition, qualitative data such as comprehensive planning documents and the wetland assessment reports were acquired from the Council to understand land-use planning and wetland regulation and preservation issues in Chatham County.

4.3.3 National Wetland Inventory

Wetland data were collected from National Wetlands Inventory, U.S. Fish and Wildlife Service, published in 1992. The data is consistent with the wetland GIS layer acquired from Chatham County Metropolitan Planning Council. It contains information about wetland area, type and classification information. The wetland inventory data are classified based on the approach developed by Cowardin et al. (1979). The GIS data's datum is North American Datum of 1983, and later projected into Georgia state plan coordinate system 1983.

4.3.4 Data Quality and Validation

Using multiple data sources is common in hedonic studies. Each data source has some level of accuracy or precision issue. Data quality issues such as inaccuracy, low precision, and outdated data problems may exist in the study. Data validation could significantly improve the understanding of data quality. For property sales data concerned, there is no efficient way to valid the accuracy of the sales record. Field calibration and sensitivity analysis are common techniques used for GIS data validity. Since no validation procedures have been taken to validate the data of the study, any inaccuracy or low precision of data may bias the estimation of wetland amenity value.

4.4 Unit of Analysis

Single family residential parcel is the unit of analysis in the study. 12,375 single family home parcels from 1991 to 2005 (inclusive) are studied.

4.5 Analysis Methods

4.5.1 Use of GIS Techniques

GIS, as a computer-based tool, provides four specific benefits in this study. First, it helps organize, manage, analyze, and display spatial information. Variables such as locational characteristics, neighborhood characteristics, and wetland related variables are geo-referenced onto a study area map. Second, GIS efficiently manages the data by integrate various geographic data sources. This research uses GIS tools to spatially join housing units’ structure data with parcel data, wetland data, neighborhood variables, and locational variables including highways, parks, historic districts, and school districts information. The integration procedures and new data generation process are elaborated in the following Section. Third, GIS tools precisely calculate quantities variables such as the number and acreage of wetlands within specified buffer zones, and distances between two points, point to polygon, or polygon to polygon to create spatial measurements needed. Fourth, GIS is used to produce maps to display residuals of hedonic price models as well as other analysis maps for visual presentation purpose.

4.5.2 Data Integration and Generation

GIS techniques are used to integrate all source data. The procedures include four steps: 1) projecting all GIS layers into the common geographic coordinate system(e.g. 1983 GCS North American 1983); 2) creating a centroid for each parcel polygon using ArcGIS; 3) joining property sales' table with the attribute table of the centroid parcel layer based on the key field of 'parcel identification number' (PIN); and 4) spatially joining the centroid layer in step three with other GIS layers (i.e. park layer, highway layer, historic district layer, wetland layer). The nearest distance to each amenity is automatically calculated during the spatial joining process.

4.5.3 Statistical Analysis

Statistical analysis employed in this study includes descriptive analysis, correlation tests, and hedonic price regression analyses. Correlational analyses are implemented to empirically test relationships between independent variables and dependent variables. Hedonic price regression analysis is used to estimate how a bundle of wetland attributes impact the amenity value of wetlands.

4.6 Variables and Measurements

4.6.1 Structural Variables

This research utilizes the public records of property sales data from Chatham County Board of Assessor. The data provide structural attributes information such as lot size, livable area, number of bedrooms and bathrooms, building quality and age, and sales year information. Table 4-1 below describes the variables, their concepts, and operational measures for housing price and structural characteristics. Descriptive statistics of the variables are presented in Section 5.2 Descriptive Analysis of Variables.

Table 4-1 Measures of Structural Variables

Concept	Variable	Operational measure
Market Value	Sales price	The sales price of single family home
	Lot size	Square feet of lot
	Livable area	Square feet of living area
Structural Characteristics	Building age	Age of house as sold
	Bedroom	Number of bedrooms
	Bathroom	Number of bathroom
	Building quality (Categorical)	Categorized quality of building (i.e. excellent = 6, very good =5, good= 4, average =3, fair = 2, low = 1)
	Sales year	The year a house is sold

The variable ‘sales price’ means the last sales price of a single family home recorded by Chatham County Appraisal Board. Median sales price of sold single family homes increased from $80,000 dollars to $180,000 dollars from 1991 to 2005. The dependent variable is the logged sales price of single-family homes because the logged sales prices are more normally distributed than unlogged ones. Sales year describes when a home was sold. About 65% of single family homes were sold after 2000.

Building age describes the actual age of a single family home when it was sold. The building age of a single family home is equal to variable 'sales year' subtracted by the built year of the home. About 50% of sold single family homes were built after 1999 (i.e. 5 to 6 years building age), and 25% single family homes were new homes sales in 2005. The sales price of a single family home generally decreases as its building age increases.

Building quality describes the quality level of a structure. It is usually accessed by Chatham County Appraisers. The value of 'building quality' is originally classified into excellent, very good, good, average, fair, and low-six categories. But since the data only include 'average' (44.8%), 'good' (38.9%), 'very good' (15.3%), and 'excellent' (0.9%) four categories. Since the distribution of the four categories is highly uneven. The value of 'building quality' is re-categorized into a new dummy variable of building quality by keeping 'average' as a group, and regrouping 'good', 'very good', and 'excellent' three categories into a new general group of 'good'. The value of the dummy variable is described as: '1' = 'good' (44.8%) and '0' = 'average' (55.2%).

4.6.2 Locational Variables

This study examines two types of locational variables: natural features related variables (e.g. parks), and physical features (e.g. historic districts and highways). All locational data were obtained from Chatham County Metropolitan Planning Council. GIS is implemented to measure the distances from a single family home to the nearest parks, historic districts, and highways. Table 4-2 below describes the variables, their concepts, and operational measures for the locational characteristics.

Locational variables are transformed to meet the linear regression assumption that the relationship between the dependent variable and independent variables should be linear. Both logged and unlogged locational variables' descriptive statistics are reported in Section 5.2 Descriptive Analysis of Variables.

Table 4-2 Measures of Locational Variables

Concept	Variable	Operational Measure
Locational Variables	Park proximity	Distance to the nearest park (feet)
	Historic district proximity	Distance to the nearest historic district (feet)
	Highway proximity	Distance to the nearest interstate/highway(feet)

4.6.3 Neighborhood Characteristics

This study uses census data to qualitatively describe the general socioeconomic characteristics of the study area. The study's unit of analysis is per household or parcel, not a census block-group, therefore the data cannot be used to describe the socio-economic characteristics of a household.

School district, land-use zoning, floodplain variables are used in hedonic analysis because the variables can describe a household's characteristics, even though households in a same neighborhood may share same school district and zoning characters. Table 4-3 describes the variables, their concepts and operational measures for some neighborhood characteristics. The three variables' descriptive statistics are displayed in Section 5.2 Descriptive Analysis of Variables.

The study area majorly involves three school districts: District 1, District 4, and District 6. Three land-use codes are analyzed in the study: 'R1' (detached single family home), ‘RA’ (residential agriculture), and ‘PUD’ (planned unit development). Two major floodplains are found in the study area: ‘X’ (within 500-year floodplains), and ‘AE’ (100-year floodplains, elevation established).

Table 4-3 Measures of Neighborhood Characteristics

Concept	Variable	Operational Measure
Neighborhood variables	School district	School districts 1, 4, and 6
	Zoning regulations	(i.e. PUD, R1, RA)
	Floodplains	AE and X

4.6.4 Wetland Amenity Variables

Three instruments are used to measure the amenity value of wetlands: wetland physical condition and characteristics, wetland accessibility, and neighborhood wetland effects. Wetland physical condition and characteristics are described by its own basic characteristics and preservation conditions by wetland regulations. Wetland basic characteristics are measured by size, types of wetland. Wetland regulations are measured by environmental overlay zone and wetland setback zone variables

Eight wetland amenity variables are used to estimate the amenity value of wetlands. Table 4-4 describes the variables, their concepts, and operational measures for the wetland variables. Descriptive statistics of the variables are analzed in Section 5.2 Descriptive Analysis of Variables.

Table 4-4 Measures of Wetland Amenities Variables

Concept	Variable	Operational measure
Wetland basic characteristics and conditions	Type	(e.g. forest shrub, marine, fresh-pond)
	Size	Acre of wetland
	Setback distance zone	100ft buffer zone
	Environmental overlay zone	Zoning code = " EO"
Wetland accessibility	Wetland adjacency	"0" = adjacent; " 1" = non-adjacent
	Wetland proximity	Distance to the nearest wetland (feet)
Neighborhood wetland effects	Number of wetlands	Within 200ft, 1/4mile, or 1/2mile buffers
	Acreage of wetlands	Within 200ft, 1/4mile, or 1/2mile buffers

4.6.4.1 Wetland Type

Three types of wetland are examined in the study. They are forest-shrub, fresh-pond, and marine. Forest-shrub wetlands tend to be located along river and streams. The wetlands have a variety of vegetation, but show the least open-water feature among the three types of wetland. Fresh-pond and marine wetlands have more open waters. What differentiates the two types of wetland is: the former is mostly located near shallow ponds or reservoirs, while the latter located near coastal reservoirs. Doss and Taff (1966) aggregated six major categories defined by Cowardin et al. (1979) into three major categories: forested, scrub, and open waters, so did Mahan et al. (2000). This study further differentiates the type of open water into coastal marine and fresh-pond wetlands for the interpretation purpose.

Different types of wetland have different impacts on nearby housing prices. Mahan et al. (2000) examined the impacts of different types of wetland on residential property values, and found that proximity to shrub and emergent wetlands negatively impact the property values, but open-water wetlands have positive impacts on the values. Doss and Taff (1996) found that open-water and shrub wetlands positively impact nearby housing prices. But forested wetlands have negative impacts on the sales prices of the properties.

4.6.4.2 Wetland Size

The size of wetlands varies across the study region. Most of small and fragmented wetlands are located in Pooler and Savannah area, while large and integrated wetlands located in unincorporated area. Section 6.2 Descriptive Statistics of Hedonic Model presents the statistics of wetland size in three sub-study areas. The impact of the size of the nearest wetland on housing sales prices has been examined by prior studies, but the results are inconsistent. Lupi et al. (1991) found that a larger size of wetland acreage in areas with lower wetland acreage more significantly increase nearby housing prices than in the areas with higher wetland acreage. Mahan et al. (2000) found that in an urban setting, increasing the size of the nearest wetland by one acre increases a property's value by $24.39. Bin and Polasky (2005) found that in a rural setting, increasing the size of the nearest wetland by 25% decreases property value by $217. But Tyrvainen and Miettinen (2000) found the proximity to a large nearest forested area is not significant at all.

4.6.4.3 Wetland Regulations

Environmental overlay zone and setback requirement are consequences of protecting wetland amenities located on or near a property. Section 6.2 Descriptive Statistics of Hedonic Model shows the number of single family homes within environmental overlay zones and outside of the zones. A few studies has found that natural amenities protected by existing environmental overlay zone may increase a single family's sales price (Lutzenhiser and Netusil 2001; Netusil 2005). Sims and Schuetz (2007) stated that an environmental overlay zone increases the values of existing homes by constraining the supply of additional homes within the zone. But Netusil (2005) argued that the effect of environmental zoning on a property's sale price is uncertain, and varies across a study region due to factors such as limitations of property development rights, homebuyer's perception of environmental zoning, and omission of relevant variables.

100-feet wetland setback buffer zone was established to protect the wetlands very close to residential properties in Savannah Chatham County. Theoretically single family homes located within a 100-feet buffer zone are negatively impacted by the zone due to the posed limitation on development rights. A few relevant studies examined the impacts of environmental regulations on property values. But their findings are not consistent. Mooney and Eisgruber (2001) estimated the influence of riparian buffers on the sales price of residential properties in Oregon, and found that the buffer zones decrease the market value of stream-front properties in the study area. The results are probably due to diminishing river view within the zones, not necessary the regulation effects of the zones. However, Shilling, Shirmans, and Guidry (1991) examined the impacts of environmental protection-related land use regulations on residential land values, and found that coastal zones and wetlands management, and designation of critical areas and wilderness have no significant effects on land values. Similarly, Cordez, Gatzlaff and Yezer (2001) found no impacts of U.S. Army Corps of Engineers shore protection activities on nearby housing prices.

4.6.4.4 Wetland Accessibility

Wetland accessibility describes the levels of private access to wetlands from a given single family residential lot. Residents can access to wetlands via two ways: direct access to wetlands or walking to wetlands from their homes. The levels of private access depend on the spatial distance between a single family home and its nearest wetland. For example, if a single family home is adjacent to a wetland, the owner of the property can access to/use the wetland from his back or side yard directly. But if the owner lives relatively far away from a wetland, he/she has to walk over certain distance to access/ use the wetland.

Spatial measurements (e.g. wetland adjacency/frontage and wetland proximity) created by GIS tools can easily describe the extent of how convenient to access a wetland in term of spatial distance. Wetland proximity (i.e. distance to nearest wetland in feet) has been used by prior wetland amenity studies (Doss and Taff 1996; Mahan et al. 2000; and Bin and Polasky 2005). Relevant studies further suggest that the immediate access to/view of amenities can be measured by ‘adjacency’ spatial concept. Weicher and Zerbst (1973) measured the amenity impacts of neighborhood parks in Columbus, Ohio using a set of dummy variables to describe immediate adjacency to protected open space. Spalatro and Provencher (2001) examined the lakefront properties in northern Wisconsin and found the amenity effects of lake-front averagely increase the values of the properties by 7 to 12 percent. Therefore a simple binary indicator of wetland frontage/adjacency is developed to measure the immediate access to/view of wetland amenity. If a residential parcel is adjacent to the boundaries of wetlands, the value of the dummy variable is 1, otherwise 0.

4.6.4.5 Neighborhood Wetland Effects

Neighborhood wetland effects describe the ambient levels of wetlands in surrounding neighborhoods. The distribution of wetland quantities directly causes the spatial variation in neighborhood wetland effects across the study area. For instance, some properties have more nearby wetlands to access to in their surrounding neighborhoods, but others have less or none to access to in the neighborhoods. The relative quantities of wetlands in surrounding neighborhoods are critical to understand the impact of wetland amenity on nearby single family home values.

Many relevant studies used ‘quantities’ measures to estimate neighborhood wetland effects within specifically defined zones. Geoghegan et al. (1997) estimated the impact of Maryland’s Patuxent watershed on residential properties, and found that increasing amount of open spaces within 100m radius of each house increases its sales price, but increasing amount of open spaces within 1000m radius decreases the price. A recent study by Tapsuwan et al. (2009) found that the number of wetlands within 1.5km of a property is positively related to the property’s sales price.

Netusil (2005) argued that a property’s sales price partially depends on amenities on the property and amenities in its surrounding neighborhood. A survey conducted by Hoehner et al. (2005) found that most of residents in Savannah-Chatham County are willing to walk about five minutes to access recreation facilities, typically one-quarter to half-mile walking distance. The maximum walking distance defined in the study is one-half mile. Based on the discussions above and in Section 3.4 Wetland Amenity Variables, this study estimates neighborhood wetland effects by measuring wetland quantities (in terms of acreage of wetlands and number of wetlands) in a single family parcel’s surrounding neighborhoods defined as three-leveled walking distance zones: 200ft, one quarter, and one half mile distance of the parcel. Note that the acreage of wetlands not only count the acres of wetlands totally within a distance zone, but also the acreage of continuous wetlands across the boundaries of the distance zone. For instance, if a wetland extends cross the boundaries of 200ft distance zone, this study counts the portion of the wetland within both the 200ft zone and one-quarter mile zone due to the assumption that residents hardly separate a continuous wetland from their neighborhood, especially when they use the wetland for outdoor activities such as walking, jogging, hiking, and hunting.

CHAPTER V

ANALYSES AND RESULTS: AN OVERALL MODEL

This chapter discusses the techniques and processes of hedonic model specification. The first section introduces variables and function forms used in model specification. Prelim analyses (i.e. descriptive and correlation analysis) are conducted to screen variables for a basic hedonic model consisting of only structural, locational, and neighborhood variables. Regression diagnostics further examine how well the basic model fits the assumptions of regression analysis. A final hedonic model including wetland amenity variables is finally presented to examine how wetland amenities generally impact single family housing prices in Chatham County.

5.1 Hedonic Price Model Specification

5.1.1 Dependent and Explanatory Variables

A hedonic model consists of two parts: a dependent variable and a set of explanatory variables. In this study the dependent variable is the sales price of a single family home, not the land value of a location. It is because the land is not usually sold separately from the structures placed upon it, although environmental amenities are mostly related to location, not a part of the structures (Freeman 1993). The sales price of a property reflects the values of both the land and its structural improvements.

The explanatory variables consist of four sets of variables: structural, neighborhood, locational variables, and wetland amenity variables. Structural attributes and other explanatory variables should be controlled to estimate the amenity value of wetlands. Several practical issues (e.g. function form selection) need to be addressed before specifying a hedonic model.

5.1.2 Functional Form

Economic theories do not provide a specific guidance on choices of functional forms of a hedonic model (Cropper, Deck and McConnell 1988). No consensuses have been achieved in prior studies about how to select a functional form. The simple functional forms on the basis of goodness of fit (e.g. the linear, the semi-log and log-linear transformation) are often used in hedonic studies for the purpose of easy interpretation of parameter estimates. In this study, hedonic pricing model is estimated in a log general form with the natural log of sales price as its dependent variable.

5.1.3 Variable Transformation

The principle of goodness of fit requires transforming both dependent variable and explanatory variables to achieve the best fit. Lake and Easter (2002) suggested log transformation of structural and neighborhood variables such as building square feet, lot size to help improve model fit.

Figures 5-1 and 5-2 show the histograms of the dependent variable (i.e. sales price) before and after log transformation. Log-transformed sales prices are more normally distributed. In addition to the dependent variable, a few explanatory variables are also log-transformed in this study. They are lot size, living area, wetland size, distance to the nearest wetland, distance to the nearest historic district, distance to the nearest park, distance to the nearest highway, and wetland quantities variables describing the acreage of wetlands within 200ft, 1/4 mile or 1/2 mile of a single family home.

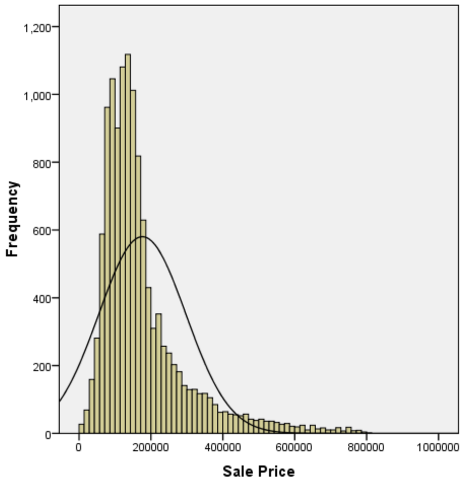

Figure 5-1 Histogram of Sales Price

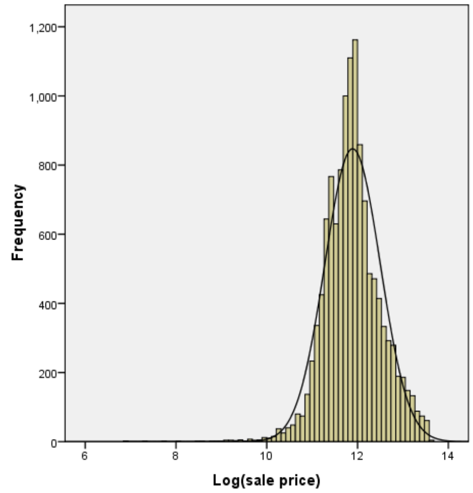

Figure 5-2 Histogram of Log Sales Price

5.1.4 Modeling Procedures

The modeling procedure involves the process of entering a group of selection variables into an ordinary least squares regression to find a good model with statistically significant explanatory variables and a satisfying adjusted R square. The selection variables are the variables screened from preliminary analysis (i.e. correlation analysis). In the modelling process, the selection variables are carried out by ‘enter’ method in SPSS software. Insignificant variables or variables with high VIF value (>10) are deleted during the process. Remaining variables return to estimate the model, and continue with the process until all survivor variables are either statistically significant or theoretical significant in the literature. A significant cut level of 5% is employed in this study.

Following the modelling procedures above, this study develops hedonic models at two levels: the basic and final model. The basic model excludes wetland amenity variables; the final model is developed based on the basic by adding wetland amenity variables. In Chapter VI, the two-level hedonic models are specified for each sub-study area to understand how the amenity value of wetlands varies across three sub-study areas.

5.2 Descriptive Analysis of Variables

5.2.1 Structural Characteristics

Table 5-1 shows the minimums, maximums, means, standard deviations, and the number of cases for both dependent variable and independent variables in the hedonic model of Chatham County. The average sales price of a single family home in Savannah-Chatham County metropolitan area is $159,883. Structural characteristics of an ‘average’ single family home are described as: the average lot size 12,946 square foot (0.3 acre), 2,715 square foot living area, 3 bedrooms, 2 bathrooms, and an average of 11 years old building age.

Section 5.2.2 correlation analysis shows that the continuous variable of ‘sales year’ is highly correlated with single family property sales price. Figure 5-3 shows the median sales price of each year since 1991. Among 11202 single family sales data, 2.5% of the sales occurred in 1991. Almost 17.8% of the single family homes were sold in 2005. Nearly one third of single family homes were sold between 1991 and 1999 (inclusive), and the rest of two thirds sold between 2000 and 2005 (inclusive).

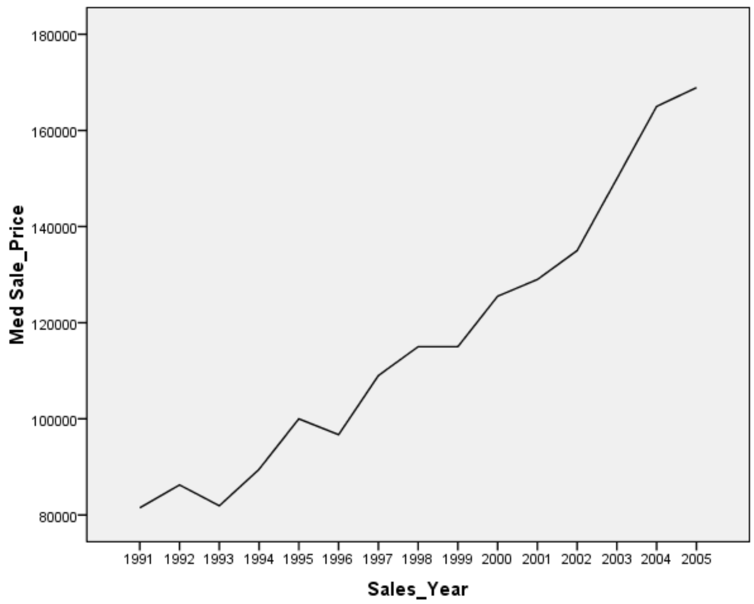

Figure 5-3 Median Sales Price from 1991 to 2005

5.2.2 Locational Characteristics

The average distance from a single family home to the nearest highway is about 14,372 foot (about 3 miles). The average distance to a park is about one mile. The impact of a historic district on housing prices is likely significant when houses are located within historic districts (Bennett 1998; Morton 2000). No or insignificant impacts of historic districts on housing sales prices are expected in this study due to the average of over 7 miles distance between single family homes and historic districts. But on the other hand, since the boundaries of historic districts are overlapped with those of Savannah downtown, .the distance to the nearest historic district also measures the distance to the central business district of Savannah, or the job center of Chatham County metropolitan area.

Table 5-1 Characteristics of Hedonic Price Model

Concept	Variable	Unit	Min.	Max.	Mean	Std. Deviation
Housing market value	Sales price	US $	10,000	537,500	159,883	90,621
	Sales price	Log($)	9.00	13.00	11.84	0.54
Structural characteristics	Lot size	Square ft.	1,738	44,099	12,946	6,583
	Lot size	Log(sq.ft)	7.46	10.69	9.36	0.47
	Living area	Square ft.	1,004	12,274	2,715	1,352
	Living area	Log(sq.ft)	6.91	9.42	7.80	0.43
	Bedrooms	Number	2	4	3.13	0.41
	Bathrooms	Number	1	4	2.08	0.41
	Building quality	Dichotomy	0	1	0.53	0.50
	Building age	Year	0	52	11.3	12.7
Location characteristics	Distance to the nearest highway	Feet	102	48,549	14,372	11,682
	Distance to the nearest highway	Log(ft)	4.63	10.79	9.15	1.06
	Distance to the nearest historic district	Feet	6,855	80,925	36,188	11,380
	Distance to the nearest historic district	Log(ft)	8.83	11.30	10.43	0.39
	Distance to the nearest park	Feet	0	22,359	6,070	3,986
	Distance to the nearest park	Log(ft)	2.03	10.01	8.40	1.07
Neighborhood characteristics	Detached single family home (R1)	Dichotomy	0	1	0.40	0.49
	Residential agriculture (RA)	Dichotomy	0	1	0.09	0.28
	Planned unit development (PUD)	Dichotomy	0	1	0.39	0.49
	Other	Dichotomy	0	1	N/A	N/A
	School district 1	Dichotomy	0	1	0.11	0.31
	School district 4	Dichotomy	0	1	0.33	0.47
	School district 6	Dichotomy	0	1	0.14	0.35
	Other	Dichotomy	0	1	N/A	N/A
Floodplains	Within 500-year floodplains (X)	Dichotomy	0	1	0.43	0.50
	100-year floodplains, elevation established (AE)	Dichotomy	0	1	0.31	0.46
	Other	Dichotomy	0	1	N/A	N/A
Sub-study areas	Pooler	Dichotomy	0	1	0.20	0.40
	Savannah	Dichotomy	0	1	0.12	0.32
	Unincorporated	Dichotomy	0	1	0.68	0.47
Wetland Amenity Characteristics	**a. Basic physical characteristics and conditions**					

Table 5-1 Characteristics of Hedonic Price Model

Concept	Variable	Unit	Min.	Max.	Mean	Std. Deviation
	Wetland size	Acre	0.02	4437	18.74	109.55
	Wetland size	Log(acre)	-3.91	8.40	2.93	4.70
	Fresh-pond	Dichotomy	0	1	0.28	0.45
	Forest shrub	Dichotomy	0	1	0.52	0.50
	Marine	Dichotomy	0	1	0.20	0.40
	Environmental overlay zone	Dichotomy	0	1	0.55	0.50
	Wetland 100ft setback zone	Dichotomy	0	1	0.18	0.38
	b. Wetland accessibility					
	Wetland adjacency	Dichotomy	0	1	0.14	0.4
	Distance to the nearest wetland	Feet	0	1723	505.3	405.3
	Distance to the nearest wetland	Log(ft)	0.03	7.45	5.9	1
	c. Neighborhood wetland effects					
	Number of wetlands within 200 ft	Number	0	6	0.43	0.68
	Number of wetlands within 1/4 mile	Number	0	18	4.39	3.12
	Number of wetlands within 1/2 mile	Number	1	38	13.54	7.00
	The acreage of wetlands within 200ft	Acre	0	145,911	80.85	2,398
	The acreage of wetlands within 200ft	Log(acre)	-1.68	11.89	3.14	2.12
	The acreage of wetlands within 1/4 mile	Acre	0	148,890	3116	19,743
	The acreage of wetlands within 1/4 mile	Log(acre)	-1.44	11.91	4.90	1.92
	The acreage of wetlands within 1/2 mile	Acre	2	377,191	10,400	37,915
	The acreage of wetlands within 1/2mile	Log(acre)	0.66	12.84	6.49	1.78

N= 11202

5.2.3 Neighborhood Characteristics

Neighborhood characteristics are measured by residential density and school district information. Residential density is characterized by Chatham County land-use zoning characters (i.e. detached single family home, planned united development and residential agriculture). The zoning characters not only indicate the residential density of a neighborhood, but also the neighborhood's design style.

Of all single family homes examined, 40% of them are located within traditional neighborhoods zoned as detached single family home (R1), another nearly 39% of single family homes located within a type of denser neighborhood with mixed-use elements - planned united development (PUD) communities. Nine percent of the homes are zoned as residential agriculture. The rest of 12% are zoned as other residential use classes. Only three school districts are statistically representative in the study area. The percentages of other school districts are less than 5% of the total cases (11202). Other districts are therefore grouped as the variable 'Other' in the Table 5-1.

Flood condition of a single family property is evaluated by two of floodplains defined by Federal Emergency Management Agency (FEMA): 500-year floodplains (X) and 100-year floodplains with elevation established (AE). The two zones are statistically representative in the area. Forty three percent of single family homes are zoned as 'X' and 31% as 'AE'. Other types of flood zone are grouped as 'Other' in the Table 5-1.

5.2.4 Wetland Amenity Characteristics

Wetland characteristics and conditions are measured by its basic physical characteristics and preservation conditions. The size of a wetland in the study area varies from 0.02 to 4,473 acres, which indicates that some wetlands are highly fragmented, while others highly preserved and integrated. Fresh pond, forest shrub, and marine are the only three major types of wetlands in the study. About 52% of wetlands are forest shrub, 20% marine wetland, and 28% fresh-pond wetlands. As discussed in Chapter IV, wetland resources in the study area are protected under two zoning regulations: wetland setback distance requirement and environmental overlay zone. Fifty five percent of wetlands are protected under environmental overlay zone, and 18% of single family homes are located within 100ft wetland setback zone.

Wetland accessibility is measured by two levels of wetland access: wetland adjacency and wetland proximity. About 14.1% of single family homes are adjacent to a wetland. The average distance to the nearest wetland is 505 foot, and the maximum distance is 1,723 foot (about one quarter mile). The statistics indicates that all single family home property owners can access at least one wetland within one-quarter mile of walking distance.

Neighborhood wetland effects are measured by the number and the acreage of wetlands within three defined distance zones: 200 foot, one quarter mile, and one half mile. 200 ft distance zone is defined as the immediate neighborhood of a single family home. Some single family owners in the study region can access to maximally six wetlands, but others have no wetlands nearby at the neighborhood block level (200ft). The number of accessible wetlands increases as proximity to wetlands decreases. In a larger neighborhood defined as the areas between one-quarter mile and one-half mile of a single family home, the owner can access at least a wetland, and 38 wetlands in maximum.

The Table 5-1 also shows that a little change of wetland quantities (i.e. number and acreage of wetlands) occurs from 200ft to one-quarter mile distance of a single family home, compared to the dramatic change of wetland quantities from the one-quarter mile to one-half mile distance zone. The dramatic change of the quantities statistics indicates that large wetlands are located relatively far away from single family residences. But in general the quantities of wetlands are ample in the surrounding neighborhoods of a single family home. The single family owners can access at least a wetland within a comfortable walking distance of one half mile.

5.3 Correlation Analysis

A simple linear correlation analysis (i.e. Pearson correlation) is performed for three purposes: 1) to understand the associations between the dependent variable and explanatory variables; 2) to quantify the strength of the associations; and 3) to detect possible collineaity issues among explanatory variables. Explanatory variables strongly and significantly associated with the dependent variable are selected for hedonic models. The variables are called selection variables in this study. The significance threshold value (p) is set at 0.05 level. If a coefficient is flagged by one asterisk (*), it indicates that the correlation is significant at 0.05 level (2-tailed). If the coefficient is flagged by two asterisks (**), the correlation is strongly significant at 0.01 level (2-tailed). When p < =0.001, the coefficient is flagged by three asterisks (***); when P < = 0.1, then flagged by a plus sign ($^+$).

5.3.1 Sales Price vs. Structural Variables

A house's structural attributes are the most influencing factors in deciding the sales price of a house. This study examines major structural variables: lot size, living square feet, building quality and age, bathrooms, and bedrooms. In general, increasing living square feet, lot square feet, number of bathrooms, and number of bedrooms have positive impacts on housing prices, while increasing building age has a negative impact on the prices (Sirmans et al. 2005). Correlation coefficients of structural variables indicate that sales price (i.e. dependent variable) is positively related to bedrooms, bathrooms, building quality, lot size, living area, but negatively to building age.

Sales price and building quality highly correlates with each other. But the correlation coefficient value decreases significantly after the sales price is logged and variable 'building quality' is recoded into a dummy variable. Due to the strong correlation with the sales price, the variable 'building quality' is selected into basic hedonic pricing models to explain how the overall quality of a single family home impacts its sales price.

It is also noted that structural variables are to some extent correlated with each other. For example, living area is correlated with lot size, number of bedrooms and bathrooms, building quality, and building age. Since correlation coefficients among structural variables are relatively small (less than 0.6), all structural variables are initially selected into basic hedonic models.

5.3.2 Sales Price vs. Locational Variables

Amenities associated with a location are important factors for home buyers to make their residence decisions. Locational variables are measured by the distances from a single family home to various amenities such as parks, highways, central business district, and transportation routes. The signs of these amenity effects depend on whether or not they impose costs or benefits to nearby homeowners. Correlation analysis shows that the distances to historic districts, parks, or highways are significantly and positively correlated with sales price, but no significant correlations exist among locational variables. Therefore all the three variables are initially selected into the basic hedonic models.

5.3.3 Sale Price vs. Neighborhood Variables

Neighborhood characteristics refer to the socio-economic characteristics of a neighborhood, such as school quality and residential density characteristics. Correlation results indicate that sales price is significantly correlated with plan unit development, detached single family home, residential agriculture, school district 1, school district 4 , school district 6, 500-year floodplains, and 100-year floodplains.

Structural, locational, and neighborhoods variables are not highly correlated with each other. Only a few pairs of variables have relatively high coefficients: variable ‘X’ (within 500-year floodplains) is negatively correlated with ‘AE’ (i.e. 100-year floodplains, elevation established) at 0.01 significance level, so is ‘PUD’ (plan unit development) and ‘R1’.

5.3.4 Sales Price vs. Sales Years

The correlation coefficients of sales price and sales years indicate that sales prices of single family homes increase rapidly from 1990s to 2000s. In order to understand each sales year's influence on the sales prices, correlation analysis between individual sales year and the sales price is conducted. Correlation coefficients with sales years remain to be significant and negative until the year of 2000, turn into insignificant in 2001, and then become significant and positive since 2001. The absolute values of the coefficients continuously drop until 1999, and then gradually increase from 2001. The signs and values of the coefficients somewhat picture the changes of Chatham County housing market over the 15-year period. 15 dummy variables of sales year are included in hedonic models to account for the influence of each sales year's market on housing sales price.

5.3.5 Sales Price vs. Sub-study Areas

Correlation coefficients between sales price and three sub-study location variables indicate that the sales price is negatively correlated with municipality 'Savannah' and positively with unincorporated area at 0.01 significant level, but insignificantly with municipality 'Pooler' variable. Sub-study area location variables are highly correlated with each other.

5.3.6 Sales Price vs. Wetland Amenity Variables

Correlation coefficients between wetland amenity variables and sales price indicate that sales price is significantly correlated with types of wetland (i.e. forest shrub, marine, and fresh-pond), wetland adjacency, the distance to the nearest wetland, the size of the nearest wetland, and wetland quantities in the surrounding neighborhoods of a single family home (i.e. number and acreage of wetlands within 200ft, one-quarter mile, and one-half mile distance of a single family home).

Specifically, sales price is negatively related to the distance to the nearest wetland, and positively to the following variables: wetland adjacency, size of the nearest wetland, wetland environmental overlay zone, and 100ft wetland setback zone. Sales price is also positively correlated with all neighborhood wetland effects variables. The signs of correlation coefficients between sales price and types of wetland vary. For instance, sales price is positively correlated with marine and fresh pond wetlands, but negatively with forest wetlands. An environmental overlay zone is related to fresh pond and marine wetlands, and therefore positively related to sales price. High flood risk areas (AE) are also related to open water wetlands, and therefore positively correlated with sales price.

The correlation relationships between wetland amenity variables and other explanatory variables are low. But among wetland variables, size of the nearest wetland is highly correlated with wetland quantities variables, and wetland quantities variables are highly correlated with each other. For instance, the acreage of wetlands within 200 ft is highly correlated with the acreage of wetlands within a quarter mile. The high correlation relationships suggest multi-collinearity issues among wetland quantities variables.

Despite of the multi-collinearity issues, all wetland quantities variables are still initially selected into final hedonic models to search for the most influential quantities variables to explain neighborhood wetland effects on housing prices. Multi-colinearity issues can be detected by collinearity statistics: tolerance and variance inflation factor (VIF). Any selection variable with a variance inflation factor greater than 10 is removed from final hedonic models. Multi-collinearity diagnostic issues are further discussed in Section 5.4 Regression diagnostics.

5.4 Regression Diagnostics

Reliable estimates from a regression model can be obtained only by closely examining if the data well fit the basic assumptions of regression analysis. Diagnoses are conducted to check the quality of the model. Plotting residuals is used to diagnose the following issues: 1) outlier detection; 2) normality tests for distribution and homogeneity; and 3) linearity (scatterplot of unstandardized residual vs. predicted value). Unstandardized residuals, standardized residuals, studentized residuals, and predicted values are automatically calculated by SPSS software when fitting a regression model. Outliers, normality, linearity, homoscedasticity, independence of residuals, and multi-collinearity issues are discussed in the following sections.

5.4.1 Outliers

Before regression analyses are conducted, data is screened for outliers. This study employs three strategies to detect extreme outliers: 1) remove cases more than three standard deviations from the mean value of the dependent variable; 2) remove ten cases having highest residuals using the visual inspection of the residual plot; and 3) properties with sales price less than $10,000. As a result, 1173 cases are removed from original 12375 single family home cases.

5.4.2 Normality

Normality is one of basic assumptions of multiple regression models. This assumption requires that each variable be normally distributed. Residuals are checked whether they are independent and normally distributed. As Figure 5-4 shows, standardized residuals appear to be approximately normally distributed. If the residual plot looks normal, which means the error term has equal variance and is independent across observations. According to Tabachnick and Fidell (1996), it is acceptable not to further screen individual variables for normality. Descriptive statistics in Table 5-1 show that all individual variables have a consistent and positive direction of skewness.

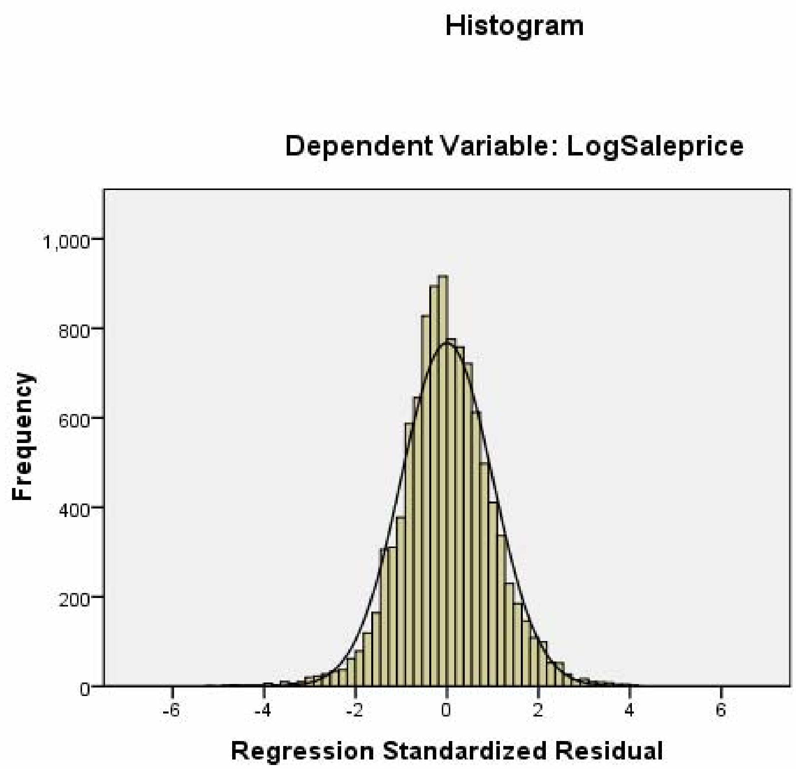

Figure 5-4 Histogram of Standardized Residual

5.4.3 Linearity and Homoscedasticity

Both linearity and homoscedasticity issues are diagnosed from residuals plots. In general, a residual scatterplot with a divergent or convergent fan shape suggests heteroscedasticity, whereas a plot with a symmetric pattern such as a cloud of points indicates homoscedasticity. Figure 5-5 shows the scatter plot of the standardized residuals with the standardized predicted values. The residual plot looks acceptable. No serious heteroscedasticity issue exists. Figure 5-6 shows no indication for nonlinearity.

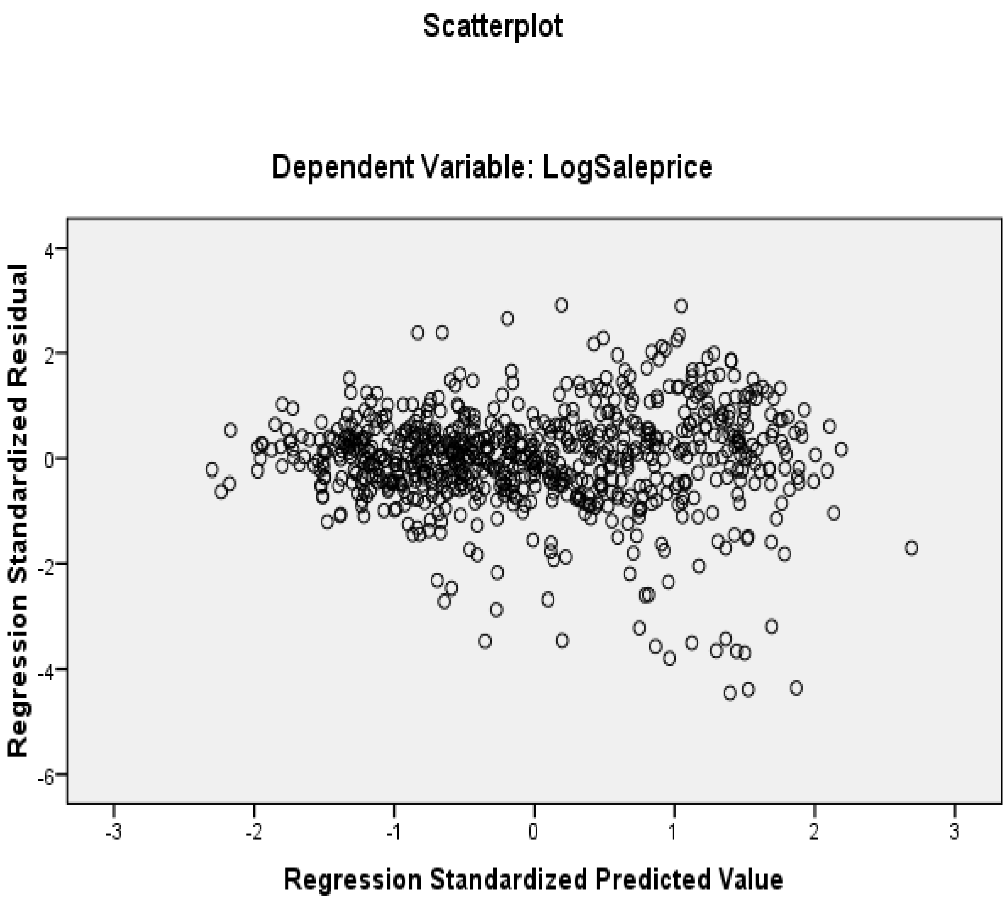

Figure 5-5 Scatterplot of Standardized Residual vs. Predicted Value

5.4.4 Multicollinearity

Multicollinearity diagnostics are conducted by checking the VIF (Variance Inflation Factor) of explanatory variables. The coefficient of VIF is obtained when an explanatory variable of interest is regressed on the remaining explanatory variables. If a variable's VIF is larger than 10, the variable is recommended to be deleted, or an alternative method should be used instead of OLS. Collinearity statistics (i.e. tolerance level and VIF value) are listed in the statistic table for final hedonic regression model.

5.5 Basic Model

5.5.1 Basic Hedonic Model and Variables

The base model consists of only structural, locational, and neighborhood dependent variables. Based on correlation analysis in Section 5.3, the following variables are initially selected into the basic hedonic pricing model: lot size (log), living area (log), number of bedrooms, number of bathrooms, building quality (dummy), building age, distance to the nearest highway (log), distance to the nearest park (log), and distance to the nearest historic district (log), 500-year floodplains (X), 100-year floodplains (AE), planned unit development (PUD), detached single family (R1), residential agriculture (RA), sale years (dummy), and sub-study locations (dummy).

Dependent variable sales price (P) is log-transformed into Ln (P) to meet the assumption of the normal distribution for linear regression. The model is described in the function below:

$$\mathrm{Ln}\ (P) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e \qquad [4\text{-}1]$$

Where β_1 = A vector of structural variables coefficients, β_2 = a vector of locational variables coefficients, β_3 = a vector of neighborhood variables coefficients.

5.5.2 Determinants of the Basic Model

Figure 5-6 shows a plot of the observed values (the sales price in a log form) versus the predicted values. The plot indicates that the hedonic regression model fits the data well.

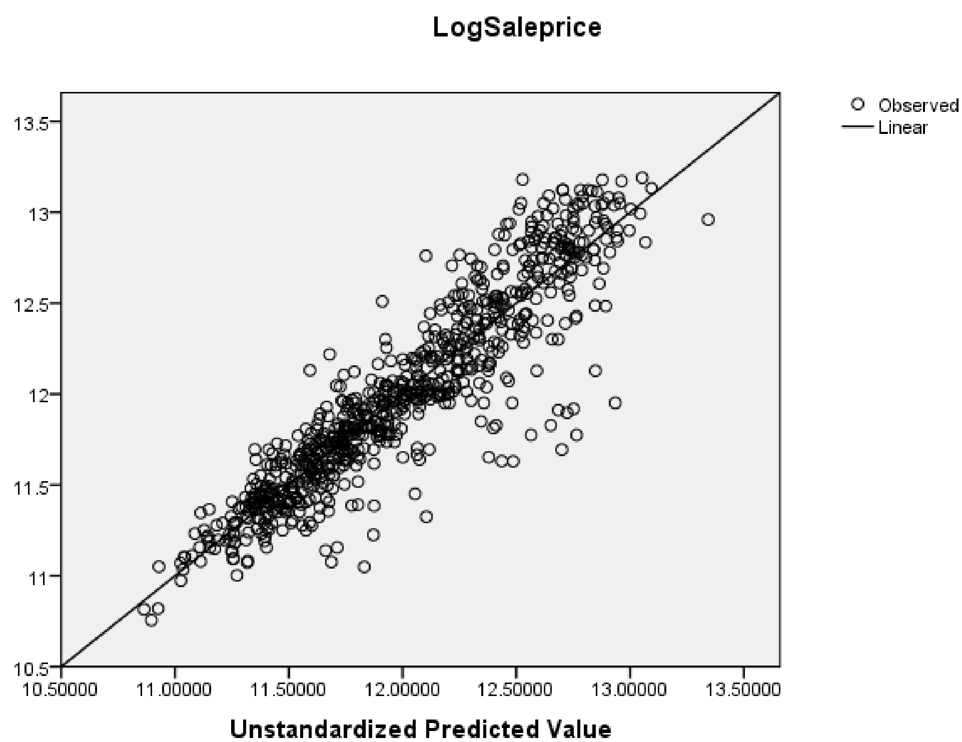

Figure 5-6 Scatterplot of Predicted Value vs. Log (Sales price)

The basic hedonic model estimates a house's sales price based on its structural, neighborhood characteristics, and locational variables. The adjusted R square of the basic hedonic model is 0.60. Structural variables in the model contribute to explaining 45% variance of the sales prices. The additional 15% variance is explained by neighborhood variables. Inclusion of locational variables doesn't significantly improve the strength of the model's power to explain the variance. The overall R square of the basic model (0.60) is lower than R squares (about 0.7) yielded by other hedonic housing studies summarized by Sirmans et al. (2005) and Malpezzi, Ozanne, and Thibodeau (1980).

Despite of the low adjusted R square, the model offers a reasonable fit to the data, largely due to the diverse locational and landscape characteristics of the study area (see the discussion in Section 4.2.3 Economy and Housing Market) and the long-term sales data (from 1991 to 2005) used in the study. Most of prior studies examined only short-period sales data. For instance, Lupi et al. (1991) used 1987-1989 sales data. Mahan et al. (2000) used residential sales occurred between June 1992 and May 1994. Netusil (2005) used 1999 to 2001 residential sales data in Portland, Oregon. The reason for using a long-period sales data is to explore the question of to what extent wetland amenities impact housing sales price in a wetland-rich area over a long-time period, regardless of the dynamic changes of housing market over time. The goal of hedonic regression analysis in this study is to explore how the amenity values of wetlands change as the amenity levels of wetlands vary across the study region, not to specify the best statistical model to predict a house's sales price.

Housing structural attributes have significant impacts on housing sales prices. As shown in Table 5-2, regression coefficients for the structural variables have expected signs and are statistically significant at 0.001 significant level. For instance, lot size, living area, and number of bedrooms and bathrooms, and building quality positively impact single family property values, while building age negatively impact the values.

All three coefficients of locational variables are statistically significant at 0.001 level, but the coefficients have different signs: -0.025*** (distance to the nearest park), 0.031*** (distance to the nearest highway), and 0.084*** (distance to nearest historic district). The coefficients indicate that residents prefer to live closer to a park, and far away from downtown areas and highways to enjoy the quietness of suburb environment. Espey and Owusu-Edusei (2001) found positive spillover effects of proximity to parks on housing prices using a data set of single family homes in Greenville, South Carolina. Richardson (1977) argued that optimal residential locations are distant from a central city with less traffic congestion, and closer to high environmental amenities.

Neighborhood characteristics significantly impact housing sales prices. For example, 'planned unit development' is positively related to the sales prices of the properties within the zone. As discussed, planned unit development is characterized by its mix-used development elements. The results reveal the popularity of a denser and mixed-use developed neighborhood in Savannah-Chatham County housing market. Song and Knaap (2003; 2004) also found that mixed-use designed neighborhoods have positive impacts on residential property values.

Single family homes zoned as 'residential agriculture' are surrounded by privately owned open space or developable spaces. Irwin and Bockstael (2001) argued that privately owned open space that surrounds a residential property is part of the same market as the residential property. Neighborhoods zoned as 'RA' have less residential density than those zoned as ‘PUD’ or traditional ‘R1’. The model shows that ‘residential agriculture’ zones are negatively related to the sales prices of the properties within the zones.

Table 5-2 Determinants of Basic Model in Chatham County

Concept	Variable	B	Std.Error	Sig.
	(Constant)	7.070	.144	.000***
Structural characteristics	Lot size (log)	.210	.009	.000***
	Living area (log)	.178	.010	.000***
	Bedrooms	.031	.009	.000***
	Bathrooms	.143	.010	.000***
	Building quality	.251	.009	.000***
	Building age	-.003	.000	.000***
Submarkets	Savannah	-.033	.014	.022*
	Pooler	-.111	.014	.000***
Sales years	Year_1991	-.614	.023	.000***
	Year_1992	-.597	.022	.000***
	Year_1993	-.561	.022	.000***
	Year_1994	-.505	.021	.000***
	Year_1995	-.428	.022	.000***
	Year_1996	-.424	.020	.000***
	Year_1997	-.428	.020	.000***
	Year_1998	-.372	.017	.000***
	Year_1999	-.263	.016	.000***
	Year_2000	-.172	.015	.000***
	Year_2001	-.121	.015	.000***
	Year_2002	-.073	.014	.000***
	Year_2004	.098	.013	.000***
	Year_2005	.180	.012	.000***
Location characteristics	Distance to the nearest highway(log)	.031	.004	.000***
	Distance to the nearest historic district (log)	.084	.012	.000***
	Distance to the nearest park (log)	-.025	.004	.000***
Neighborhood characteristics	Planned unit development (PUD)	.077	.008	.000***
	Residential agriculture (RA)	-.069	.016	.000***
	School district 1	.177	.015	.000***
	School district 4	.168	.010	.000***
Floodplains	100-year floodplains (AE)	.042	.008	.000***

R = 0.78; R^2 = 0.61; Adjusted R^2 = 0.60

Detached single family (R1) zone has no significant impact on housing price because the properties examined in this study are all single family homes. Due to the statistical insignificance of ‘R1’, the variable is dropped from the basic hedonic model. School district variables have expected positive signs: good school districts (e.g. school district 1 and 4) have positive impacts on housing prices. Other school districts are dropped from the model due to their statistical insignificance.

In addition to the structural and neighborhood variables discussed above, the model shows that 100-year floodplains are positively related to housing prices at 0.001 significant level. Variable ‘500-year floodplains’ is insignificant and therefore dropped from the model. Dichotomy location variables of three sub-study areas are initially included in the basic model to explain spatial variations across different housing submarkets. But only variable ‘Pooler’ and ‘Savannah’ are significant at 0.001 level. Sales years continue playing significant roles in explaining the changes of sales prices over time. The coefficients of 15 dummy variables are listed in Table 5-2.

In brief, the coefficient estimates of structural, locational and neighborhood variables reflect housing pricing patterns in Chatham County: structural variables play dominant roles in deciding the sales prices of single family homes. Neighborhood characteristics and locational amenities are less influential in explaining the sales prices of the properties. The results can be further explained by residential location and market segmentation theories: Savannah-Chatham County has a modern urban land-use model with mutli-centers. Every sub-center has its own unique set of locational amenities to compete in its own housing submarket, providing various types of housing characterized by their unique cultural and environmental amenities. Home buyers can freely select housing substitutes to meet their housing needs or preferences for environmental amenities. The diversity of the Chatham County housing market causes the difficulties in identifying universal and appropriate locational variables to specify a satisfying overall model for Chatham County. As a result, this study produces a relatively low R square.

5.6 Final Hedonic Model

The final model controls the effects of structural, locational, and neighborhood variables to estimate the impacts of wetland amenity variables on housing price. Table 5-3 reports the coefficients of all the variables. The final model explains 62% variance of sales prices. Inclusion of wetland amenity variables does not significantly increase the adjusted R square of the model. The increase of 2% variance is much smaller than 45% variance explained by structure variables and 15% explained by neighborhood variables.

Compared to the R squares produced by a few wetland amenity studies, the adjusted R square is relatively low. For instance, Mahan et al. (2000) examined the impact of urban wetlands using a total of 14, 485 residential sales from 1922 to 1994 in Multnomach County in Oregon. Their study produced a model with 0.75 R square. Netusil (2005) examined the impact of environmental overlay zone on residential properties, and his model's R square is also around 0.75.

The estimates of structural variables and neighborhood variables are as significant as those in the basic model. No significant changes occur in the estimates of structural and neighborhood variables. Lot size, living area, number of bedrooms and bathrooms, building quality positively impact single family homes' sales prices. Increasing building age decreases housing prices. Variables 'PUD' and 'RA' and school districts have the same expected signs as those in the basic model. However, all three locational variables turn into insignificant in the model. It is largely due to the diversity of locational amenities issues discussed in the basic model's Section. Table 5-3 doesn't list the coefficients of individual sales year, because the value and signs of the coefficients are almost consistent with those in the basic model.

Table 5-3 Determinants of Final Model in Chatham County

Variable	B	Std.Error	Sig.	Collinearity Statistics	
(Constant)	7.339	.158	.000***	**Tolerance**	**VIF**
Lot size (log)	.206	.009	.000***	.589	1.696
Living area (log)	.172	.011	.000***	.508	1.967
Bedrooms	.034	.009	.000***	.810	1.235
Bathrooms	.142	.011	.000***	.575	1.739
Building quality	.254	.010	.000***	.449	2.226
Building age	-.003	.000	.000***	.371	2.698
Savannah	-.051	.018	.004***	.413	2.418
Pooler	-.110	.016	.000***	.287	3.485
Planned unit development (PUD)	.094	.010	.000***	.517	1.933
Residential agriculture (RA)	-.070	.018	.000***	.465	2.150
School district 1	.179	.018	.000***	.360	2.775
School district 6	.169	.016	.000***	.205	4.879
100-year floodplains (AE) * Marine	.092	.014	.000***	.597	1.676
Wetland size (log)	-.005	.002	.001***	.785	1.274
Environmental overlay zone	-.044	.014	.002**	.220	4.551
Setback distance zone * Marine	-.096	.040	.016*	.340	2.941
Wetland adjacency * Marine	.146	.041	.000***	.351	2.847
Distance to the nearest wetland (log)	-.018	.004	.039*	.722	1.384

R = 0.79; R square = 0.62; Adjusted R Square 0.62

Correlation analysis in Section 5.3 finds that floodplains are highly related to fresh pond and marine wetlands. Three interactive terms between types of wetland and 100-year floodplains are therefore developed and analyzed in the final model. But only the interactive term of 100-year floodplains and the 'marine' type of wetland is positively significant. The positive sign indicates that the sales prices of houses within 100-year floodplains along with ‘marine’ wetlands are probably more impacted by the positive open-water amenity effects associated with the coastal wetlands than the negative externality of flood risk involved.

5.7 The Effects of Wetland Amenities in Chatham County

The final model shown in Table 5-3 indicates that a few wetland amenity variables significantly impact housing sales price: wetland type, wetland size, wetland adjacency, wetland proximity, and environmental regulation zones. Wetland quantities measures (i.e. the number and acreage of wetlands within different distance zones) are insignificant and therefore dropped from the model. Prior wetland amenity studies have found that wetland size, wetland type, distance to wetlands matters to nearby residential property. But none of the studies have discussed about the effects of wetland adjacency and environmental regulation zones on residential property values. Each significant wetland amenity variable is discussed as follows:

This study finds that a house’s sales price is negatively related to the size of the nearest wetland (-0.005*). Namely, a large nearest wetland decreases the sales prices of nearby single family homes in Chatham County. Bin and Polasky (2005) also found the negative impacts of the size of the nearest wetland on housing price in rural settings. But Lupi et al. (1991) and Mahan et al. (2000) found the positive amenity effect of a large size wetland on nearby residential properties.

Consistent with prior wetland amenity studies (Mahan et al. 2000; Doss and Taff 1996), this final model confirms that wetland proximity matters to nearby single family home owners. Coefficients reported in Table 5-3 indicate that decreasing distance to a wetland increases a nearby single family's sales price. But no preferences for the types of the nearest wetland are revealed in the model.

The amenity value of wetlands to residents who live adjacent to a wetland is strongly influenced by the type of the wetland. The results show that the effects of wetland adjacency are statistically significant only when the type of the wetland is open water related wetlands. Housing sales prices are positively impacted by adjacent marine wetlands. The finding is consistent with prior relevant studies (Doss and Taff 1996; Mahan et al. 2000; Bin and Polasky 2006; Mooney and Eisgruber 2001; Spalatro and Provencher 2001). Other coastal property valuation studies also confirm that coastal-front views strongly increase a house's sales price (Landry and Hindsley 2007; Bin and Kruse 2006).

Environmental regulation zones (i.e. environmental overlay zone and wetland setback distance zone) have negatively significant impacts on the sales prices of single family homes within the zones. Interestingly, compared to the positive impact of adjacency to a marine wetland on housing sales price, a 100ft setback distance zone of a marine wetland significantly and negatively impact the sales prices of single family homes within the zone. The two contradictory findings indicate that the amenity effects of marine wetlands decrease dramatically from waterfront properties to non-waterfront properties.

No significant neighborhood wetland amenity effects are found in the model. It can be explained by the fact that wetland resources in terms of quantities are sufficient in

Chatham County on the average. Single family home buyers are not willing to pay for marginal benefits of additional wetland quantities.

5.8 The Implicit Prices of Wetland Attributes

The marginal implicit prices of wetland attributes are computed using the coefficient estimates presented in table 5-3. Using the same approach as Mahan et al. (2000), the marginal implicit prices of non-logged wetland amenity variables are equal to the coefficients multiplied by the mean house sales price (i.e. $159,883). Adjacency to a marine wetland increases property sales price by $23,343. If a house is located within 100ft setback distance zone of a marine wetland or environmental overlay zone, the sales price of the house is reduced by $15,349 or $7,035 respectively. Using the mean house sales price and the maximum distance to nearest wetland of 1723 ft, the marginal implicit price is $(.018 \times \$\ 159{,}883)/1{,}723 = \$1.6703$. Moving 1,000ft closer to a wetland increases the average house value by $1,670. This study produces the same coefficient (0.018) for the variable ‘distance to the nearest wetland’ as the final model produced by Mahan et al. (2000). But they yielded a lower marginal implicit price ($436) for wetland proximity variable using $122,570 mean house price and 1 mile initial distance.

CHAPTER VI

ANALYSES AND RESULTS: THREE SEPARATE MODELS

6.1 Introduction

This Chapter focuses on examining if the amenity value of wetlands on the sales prices of single family homes varies across a metropolitan area. Bourassa et al. (1999) argued that if spatial variations in term of implicit prices of housing attributes exist, and the accurate estimation of coefficients for each submarket is concerned, separate hedonic price models should be applied to generate more accurate coefficients estimate of housing attributes across submarkets. Due to the different characteristics of structural variables, neighborhood variables, especially the uneven distribution of wetlands across Savannah-Chatham County metropolitan area, separate hedonic models are developed to understand how and to what extent wetland amenities impact housing price across different sub-regions, and which wetland amenity variables are influential in deciding the amenity value of wetlands in each of the sub-regions.

Cho et al. (2008) argued that it is problematic for many open space amenities hedonic studies to ignore the endogeneity of open space, and assume that the effects of open space are constant across the market. Cheshire and Sheppard (1995) estimated the effects of open space on the residential property values using separate datasets from two medium sized towns in England. They found that the amenity value of open spaces depends on the amount of open spaces available in the two towns. Anderson and West (2003) also obtained quite different results for central city households versus suburban households in the Minneapolis area. Geoghegan (2002) found different results for agricultural open space value in different counties in Maryland. Anderson and West (2006) estimated the amenity value of open spaces in Minneapolis-St. Paul metropolitan area (Twin Cities), and found that the amenity effects of proximity to open spaces vary across different neighborhoods. Walsh (2003) argued that the effects of development restrictions depend on the characteristics of sub-regions where the restriction are imposed. Netusil (2005) also pointed out that the effects of environmental zoning on housing price depend on study locations and a variety of other issues such as amenity types, amenities on a property and amenities in its surrounding neighborhood, perceptions of environmental amenities, and types of environmental regulations.

Wetland amenity studies suggest that the amenity value of wetlands is decided by both wetland characteristics and more importantly the characteristics or locations of the study setting: rural or urban environment. Bin and Polasky (2005) concluded that the negative effects of wetlands to nearby residential property owners in a rural area surrounded with numerous wetlands. They specifically found that high wetland percentage within a quarter mile of a property, closer proximity to a wetland, and a large size of the nearest wetland are negatively related to lower residential property values. But other studies found that closer proximity and increasing size of the nearest wetland in urban area increase nearby property values (Lupi et al. 1991; Doss and Taff 1996; Mahan et al. 2000).

But no previous wetland amenity studies have examined spatial variations in the amenity value of wetlands across a metropolitan area. In Chatham County, 43% of its land area is covered by wetlands. The characteristics of its neighborhoods are strongly influenced by wetland resources. In Chapter VI, separate hedonic models are analyzed to understand the impacts of wetland amenities in three sub-study areas. The three sub-study areas are selected based on their municipal boundaries and socio-economic and environmental characteristics, representing three different types of study setting: rural (Pooler), urban (Savannah), and suburban (unincorporated areas) respectively.

6.2 Descriptive Statistics of Hedonic Model

6.2.1 Non-wetland Characteristics

Shown in Table 6-1, structural and neighborhood characteristics vary across the three sub-study areas. The average sales price of single family homes sold in unincorporated area are the highest ($169,409), Savannah the lowest ($123,190). But Savannah has the highest average building age among the three areas (about 25 years old). Single family owners in Pooler enjoy the largest livable area on average 3,014 square foot. Properties in Savannah have the smallest livable area of 2,342 sqft. Twenty eight percent (28%) of the total 1335 single family homes in Savannah are evaluated as ‘good’ quality or above. Seventy six (76%) of the total of 2250 single family homes in Pooler is evaluated as ‘good’ quality or above. About 50% of the total 7627 single family homes in unincorporated area are evaluated as ‘good’ quality or above. Neighborhood and locational characteristics also tend to be different among the three sub-study areas. For instance, single family residents in Savannah have the shortest average walking distance to a park and a historic district, and fewest number of single family homes zoned as ‘R1’ and ‘PUD’.

Table 6-1 Descriptive Statistics of Variables in Three Sub-study Areas

Variables	Pooler				Savannah				Unincorporated			
	Min.	**Max.**	**Mean**	**Std.**	**Mini.**	**Max.**	**Mean**	**Std.**	**Min.**	**Max.**	**Mean**	**Std.**
Sales price($)	11,000	452,000	148,859	52,348	13,000	427,000	123,190	63,710	10,000	537,500	169,409	100,677
Lot size (sq.ft)	7,050	42,356	11,992	4,046	4,730	42,767	11,879	5,266	1,738	44,099	13,403	7,286
Livable area (sq.ft)	1,006	9,952	3,014	1,584	1,004	9,434	2,342	1,085	1,004	12,274	2,696	1,304
Bedrooms	2	4	3.2	0.4	2	4	3.1	0.4	2	4	3.1	0.4
Bathrooms	1	3	2.1	0.3	1	3	1.9	0.5	1	4	2.1	0.4
Building age (years)	0	51	4.2	7.1	0	52	24.8	16.1	0	52	11	11.3
Building quality	0	1	0.76	0.43	0	1	0.28	0.45	0	1	0.5	0.5
Distance to the nearest historic district	29,409	57,476	48,062	4,949	6,855	57,730	28,306	11,431	9,059	80,925	34,165	10,205
Distance to the nearest park	0	13,447	5,597	2,559	0	21,713	1,932	3,665	0	22,359	6,925	3,900
Distance to the nearest highway	125	18,613	7,320	3,359	2,327	39,637	25,612	8,886	102	48,549	14,433	12,087
Within 500-year floodplains (X)	0	1	0.23	0.42	0	1	0.02	0.13	0	1	0.56	0.5
Within 100-year floodplains (AE)	0	1	0.01	0.1	0	1	0.03	0.17	0	1	0.44	0.5
Planned united development (PUD)	0	1	0.27	0.44	0	1	0.12	0.33	0	1	0.48	0.5
Detached single family home (R1)	0	1	0.73	0.44	0	1	0	0.05	0	1	0.38	0.48
Residential agriculture (RA)	0	1	0	0.05	0	1	0.01	0.06	0	1	0.12	0.33
School district 1	N/A	N/A	N/A	N/A	0	1	0.01	0.1	0	1	0.16	0.36
School district 4	N/A	N/A	N/A	N/A	0	0	N/A	N/A	0	1	0.48	0.5
School district 6	N/A	N/A	N/A	N/A	0	1	0.77	0.42	0	1	0.07	0.26
Wetland size (acre)	0.23	242	6.3	35.28	0.41	692	16	43.73	0.02	4437	21	143
Fresh-pond	0	1	0.07	0.26	0	1	0.08	0.27	0	1	0.37	0.48
Forested	0	1	0.93	0.26	0	1	0.76	0.42	0	1	0.37	0.48
Marine	0	0	0	0	0	1	0.17	0.38	0	1	0.26	0.44
Within 100 ft setback zone	0	1	0.09	0.29	0	1	0.21	0.41	0	1	0.2	0.4
Within Environmental overlay zone	0	1	0.27	0.44	0	1	0.06	0.24	0	1	0.71	0.45
Wetland adjacency	0	1	0.04	0.2	0	1	0.20	0.4	0	1	0.16	0.37
Distance to the nearest wetland	0	1723	548	359	0	1719	622	466	0	1722	473	401
Number of wetlands within 200ft	0	2	0.29	0.51	0	3	0.26	0.5	0	6	0.5	0.73
Number of wetlands within ¼ mile	0	10	3	1.9	0	8	2.2	1.4	0	18	5.2	3.3
Number of wetlands within ½ mile	1	21	11	3.7	1	23	7.5	3.1	1	38	15.3	7.4
The acreage of wetlands within 200ft	0	259	31	71	0	692	19	51	0	145,911	106	2,896
The acreage of wetlands within ¼ mile	0	735	182	101	0	2,045	164	321	0	148,890	4,468	23,733
The acreage of wetlands within ½ mile	8	1085	388	150	14	2,681	614	714	2	377,190	14,966	45,082
	N= 2250				**N = 1335**				**N= 7627**			

6.2.2 Wetland Characteristics

The distribution of wetlands greatly varies across the three sub-study areas in terms of types and size of wetland, wetland regulations, and number and acreage of wetlands available in the surrounding neighborhoods of a home. For instance, the average size of wetland in Pooler is only 6.3 acres, but in unincorporated area it increases to 21 acres. Savannah has the median size of 16 acres. Savannah and Pooler have much more forested wetlands than fresh pond wetlands, and nearly no marine wetlands. In unincorporated area, the types of wetlands are distributed evenly: 37% fresh pond, 37% forested, and 26% marine wetlands.

On average 71% of single family home residents are living within an environmental overlay zone in unincorporated area, 27% in Pooler, and only 6% in Savannah. In Savannah and unincorporated area, a relatively high percentage of single family homes (over 20%) are located within a 100ft wetland setback zone. But in Pooler only 9% of its single family homes are actually within the zone and 4% of the homes adjacent to a wetland. The statistics indicates that majority of single family homes in Pooler are not very spatially close to a wetland. But 20% of homes in Savannah and 16% of homes in unincorporated area are adjacent to a wetland. The average distance to the nearest wetland is 473ft in unincorporated area, 548ft in Pooler, and 622 ft in Savannah.

The discriptives of wetland quantities measures are also widely different. More number and acreage of wetlands are available in the neighborhoods of unincorporated area and Pooler. The statistics for the three sub-regions indicates that a large number of small size wetlands are located in Pooler, and a large number of large size wetlands are in unincorporated area where wetlands are well preserved. Compared to the quantities of wetlands in Pooler and unincorporated area, a fewer wetland resources are available in Savannah. The spatial variation in housing attributes, especially wetland resources suggests that separate models be applied to understand how the amenity value of wetlands to nearby residents varies with different study settings.

6.3 Hedonic Models in Pooler

6.3.1 Basic Hedonic Model

A basic hedonic model consisting of structural, locational, and neighborhood variables is reported in Table 6-2. The basic model has 0.60 adjusted R square.

Table 6-2 Determinants of Basic Model in Pooler

Concept	Variable	B	Std.Error	Sig.
	(Constant)	8.841	.245	.000***
Structural characteristics	Lot size (log)	.134	.021	.000***
	Living area (log)	.163	.017	.001***
	Bedrooms	.057	.017	.001***
	Bathrooms	.067	.020	.001***
	Building quality	.257	.019	.000***
	Building age	-.003	.001	.000***
Sales years	Year_1991	-.623	.071	.000***
	Year_1992	-.508	.056	.000***
	Year_1993	-.597	.063	.000***
	Year_1994	-.618	.052	.000***
	Year_1995	-.437	.047	.000***
	Year_1996	-.480	.039	.000***
	Year_1997	-.387	.040	.000***
	Year_1998	-.343	.035	.000***
	Year_1999	-.304	.030	.000***
	Year_2000	-.113	.023	.000***
	Year_2001	-.079	.021	.000***
	Year_2002	-.047	.020	.019*
	Year_2004	.097	.018	.000***
	Year_2005	.116	.018	.000***
Floodplains	100-year flooding zone, elevation established (AE)	-.086	.054	.011*

R = 0.78; R^2 = 0.61; Adjusted R^2 = 0.60

Structural variables are significant and have expected signs. Most of locational and neighborhood variables are statistically insignificant, and therefore dropped from the model. Only 100-year floodplains have negative impacts on property values as expected.

6.3.2 Final Model

A final model is specified for Pooler municipality. Table 6-3 reports the estimates of its variables. The model generates an adjusted R square of 0.62. The low R square is partially due to the long-term data set used, but more possibly because of several issues: 1) no or less impacts of wetlands on housing sales prices in rural setting; 2) inappropriate wetland valuation methods used for rural setting; or 3) omission of important locational or other housing variables.

Consistent with the basic model, structural variables are still significant and have expected signs, and locational and neighborhood variables remain insignificant. 100-year floodplains decrease the sales prices of houses within the plains, especially when the floodplains are located along with ‘forest-shrub’ wetlands with less open-water features. The negative impacts are possibly due to the disamenity effects generated by forested wetlands in a rural setting.

6.3.3 The Effects of Wetland Amenities in Pooler

Only four wetland amenity variables are statistically significant: forested wetlands, size of the nearest wetland, and wetland adjacency. Forested wetlands, the dominant type of wetland in Pooler, have negative impacts on nearby single family homes. Adjacency to wetlands is therefore undesirable for residents in Pooler. The size of the nearest wetland consistently plays the same negative role in influencing housing price as the overall model for Chatham County. Surprisingly, distance to the nearest wetland is insignificant in the model. Environmental regulations have no significant impacts on housing price. It is probably due to the fact that no or less regulations have been required to regulate developments on or near wetlands in Pooler.

Pooler's final model demonstrates a quite different pattern about how wetland amenities impact housing prices. The model picks up only disamenities effects of wetlands. It indicates that in a rural setting a wetland tends to be a disamenity to residents. However, Landry and Hindsley (2007, p.237) argued that "it does not imply that wetlands in a rural setting have no value, but rather than rural landowners are not willing to pay a premium to locate near wetlands or there is some disamenity associated with these wetlands." They also suggested that hedonic models may not be the best method to estimate many of public benefits provided by rural wetlands, because the models mostly pick up the disamenities of a wetland.

Table 6-3 Determinants of Final Model in Pooler

Variable	B	Std. Error	Sig.	Collinearity Statistics	
(Constant)	9.333	.246	.000***	**Tolerance**	**VIF**
Lot size (log)	.141	.023	.000***	.717	1.395
Living area (log)	.106	.019	.000***	.415	2.408
Bedrooms	.083	.020	.000***	.698	1.432
Bathrooms	.064	.026	.013*	.591	1.692
Building quality	.287	.019	.000***	.430	2.327
Building age	-.003	.001	.000***	.333	3.001
100-year floodplains (AE) * Forest	-.104	.054	.050*	.852	1.174
Forest shrub	-.084	.037	.022*	.493	2.026
Wetland size (log)	-.021	.004	.000***	.737	1.358
Wetland adjacency	-.085	.028	.002***	.870	1.149

R = 0.79; R square = 0.62; Adjusted R Square 0.62

6.3.4 The Implicit Prices of Wetland Attributes

Implicit market prices for wetland attributes are computed using the coefficient estimates presented in Table 6-3. Using the same approach as Mahan et al. (2000), the marginal implicit prices of non-logged wetland amenity variables are equal to the coefficients multiplied by the mean house price in Pooler (i.e. $148,859). Single family homes within an environmental overlay zone have on average $9,527 lower sales price than those outside of the zone. Adjacency to a wetland reduces property sales price by $12,653. Since 93% of wetlands in Pooler are forested wetlands, the majority of wetlands adjacent to single family homes in Pooler are most likely forested wetlands. Furthermore, if the nearest wetland to a house is a forest wetland, its sales price is reduced by around $12,504, similar to the implicit price for the variable of ‘wetland adjacency’.

6.4. Hedonic Models in Savannah

6.4.1 Basic Hedonic Model

The basic model has a comparable adjusted R square (0.70) with prior hedonic pricing studies. Table 6-4 reports the estimates of its variables. Structural variables are still significant and have expected signs. Coefficients of locational characteristics indicate that decreasing distance to park increase the sales prices of nearby single family homes, increasing distance to historic districts positively impact the sales prices. Note that it doesn’t mean that historic districts have no impacts on housing prices. Since the average distance to the nearest historic districts is averagely very far (around 5.36 miles), and the single family homes examined here are mostly located in the suburban areas of Savannah where wetlands are distributed and neighborhoods have high environmental quality, less impacts of historic districts on housing prices are expected. The results also indicate that residents in Savannah prefer to live relatively far away from downtown area to enjoy high environment amenities offered by suburban areas or by living close to a park. 100-year floodplains still have negative impacts on housing sales prices. Other variables are dropped from the model due to their statistical insignificance.

Table 6-4 Determinants of Basic Model in Savannah

Concept	**Variable**	**B**	**Std.Error**	**Sig.**
	(Constant)	6.696	.280	.000***
Structural characteristics	Lot size (log)	.197	.025	.000***
	Living area (log)	.262	.025	.000***
	Bedrooms	.037	.021	.049*
	Bathrooms	.164	.022	.000***
	Building quality	.240	.024	.000***
	Building age	-.004	.001	.000***
Sales year	Year_1991	-.825	.041	.000***
	Year_1992	-.714	.040	.000***
	Year_1993	-.742	.035	.000***
	Year_1994	-.666	.039	.000***
	Year_1998	-.419	.077	.000***
	Year_1999	-.389	.034	.000***
	Year_2000	-.363	.032	.000***
	Year_2001	-.287	.031	.000***
	Year_2002	-.247	.029	.000***
	Year_2003	-.185	.030	.000***
	Year_2004	-.060	.026	.023*
Location characteristics	Distance to the nearest historic district (log)	.124	.022	.000***
	Distance to the nearest park (log)	-.041	.010	.000***
	100-year floodplains (AE)	-.133	.051	.009**

R = 0.84; R square = 0.70; Adjusted R Square 0.70

6.4.2 Final Model

A final model for Savannah municipality is presented in Table 6-5. The model generates a relatively high adjusted R square (0.75). The high R square value could suggest that the effects of wetland amenities on housing sales prices in an urban setting are significant due to the fact that wetland resources are relatively scarce in an urban setting like Savannah. The scarcity of wetlands in an urban setting increases residents' willing to pay for the amenity value of wetland amenities. In the model, most of structural variables are significant and have expected signs as its basic model. But the impact of 100-year flood plains is statistically insignificant and therefore dropped from the final model.

Table 6-5 Determinants of Final Model in Savannah

Variable	B	Std. Error	Sig.	Collinearity Statistics	
(Constant)	6.173	.323	.000***	**Tolerance**	**VIF**
Lot size (log)	.202	.028	.000***	.630	1.586
Living area (log)	.253	.026	.000***	.639	1.564
Bedrooms	.057	.022	.011***	.807	1.239
Bathrooms	.167	.023	.000***	.546	1.833
Building quality	.231	.027	.000***	.560	1.784
Building age	-.003	.001	.005***	.333	3.001
Distance to the nearest historic district (log)	.129	.022	.000***	.454	2.203
Distance to the nearest park (log)	-.051	.010	.000***	.630	1.587
Wetland size (log)	.022	.006	.000***	.832	1.202
Environmental overlay zone	.099	.049	.043*	.829	1.206
Distance to the nearest wetland (log)	-.015	.011	.037*	.774	1,292

R = 0.87; R square = 0.76; Adjusted R Square 0.75

6.4.3 The Effects of Wetland Amenities in Savannah

Compared to the previous two final models, Savannah's final model demonstrates that in an urban setting the impacts of size of the nearest wetland and wetland proximity are positively significant, while types of wetland turn into insignificant. The results indicate that residents prefer to live close to a large wetland over a small one. The finding is contradictory to prior final models, but consistent with some of prior wetland amenity studies (Mahan et al. 2000; Doss and Taff 1996; Lupi et al. 1991). In addition, environmental overlay zone is statistically significant in the model, and has positive impacts on the sales prices of single family homes within the zone. It is probably due to the fact that in an urban setting wetlands are often functioned as important open spaces for recreation purpose, and that environmental overlay zone successfully preserves the environmental quality of urban neighborhoods by limiting the supply of additional house supply within the zone.

6.4.4 The Implicit Prices of Wetland Attributes

Implicit market prices for wetland attributes are computed using the coefficient estimates presented in Table 6-5. Using the same approach as Mahan et al. (2000), the marginal implicit prices of non-logged wetland amenity variables are equal to the coefficients multiplied by the mean house price in Savannah (i.e. \$123,190). Single family homes within environmental overlay zones have on average \$12,186 higher sales price. Using the mean sale price and the maximum distance to nearest wetland of 1719 ft, the marginal implicit price for wetland proximity is (-.015 × \$ 123,190)/1,719 = \$1.0750. Moving 1,000ft closer to a wetland increases the average house value by \$1,075.

6.5 Hedonic Models in Unincorporated Area

6.5.1 Basic Hedonic Model

The basic model's adjusted R square is 0.58. Table 6-6 reports the estimates of its variables. Structural variables are significant and have expected signs. The coefficients of locational variables indicate that decreasing distance to park increases housing prices; that increasing distances to historic districts and highways positively impact the sales prices. Similar to the results in Savannah's basic model, residents in unincorporated area enjoy high quality environment amenities provided by a suburban setting, but 100-year floodplains have positive impact on the prices instead. School district variables turn into significant in the model. Other neighborhood variables are not significant and therefore dropped from the model.

Table 6-6 Determinants of Basic Model in Unincorporated Area

Concept	Variable	B	Std.Error	Sig.
	(Constant)	7.381	.186	.000***
Structural characteristics	Lot size (log)	.191	.011	.000***
	Living area (log)	.223	.013	.000***
	Bedrooms	.026	.011	.023***
	Bathrooms	.159	.013	.000***
	Building quality	.279	.012	.000***
	Building age	-.003	.000	.000***
Sales year	Year_1991	-.808	.029	.000***
	Year_1992	-.842	.027	.000***
	Year_1993	-.770	.029	.000***
	Year_1994	-.708	.027	.000***
	Year_1995	-.633	.026	.000***
	Year_1996	-.624	.024	.000***
	Year_1997	-.644	.023	.000***
	Year_1998	-.592	.020	.000***
	Year_1999	-.475	.019	.000***
	Year_2000	-.405	.020	.000***
	Year_2001	-.350	.019	.000***
	Year_2002	-.292	.018	.000***
	Year_2003	-.209	.017	.000***
	Year_2004	-.100	.016	.000***
Location characteristics	Distance to the nearest historic district (log)	.047	.016	.003***
	Distance to the nearest park (log)	-.018	.005	.000***
	Distance to the nearest highway (log)	.034	.005	.000***
School district	School district 1	.156	.017	.000***
	School district 4	.200	.011	.000***
Floodplains	100-year floodplains (AE)	.046	.009	.000***

R = 0.76; R square = 0.58; Adjusted R Square 0.58

6.5.2 Final Model

Table 6-7 reports the estimates of all variables of the final model. Sharing a similar low value of adjusted R square as Pooler's and the overall Chatham County's final model, the model generates an adjusted R square of 0.60. In the model, structural variables are significant and have expected signs. Similar to the results as its basic model, locational variables 'distance to the nearest historic district' and 'distance to the nearest highway' are positive and statistically significant at 0.01 level. But park proximity is insignificant and dropped from the model. It is largely due to the large quantities of wetlands/green spaces available in unincorporated area, which leads to the insignificance of park amenities. School districts keep positive and statistically significant as in its basic model. Single family homes zoned as 'planned unit development' are related to higher sales prices, while homes zoned as 'residential agriculture' related to lower sales prices. The impacts of 100-year floodplains located along with 'marine' wetlands on housing price are significantly positive.

6.5.3 The Effects of Wetland Amenities

Compared to prior three final models, the model suggests that the impacts of wetland amenities are diverse and mixed in terms of number of statistical significant variables and direction of their signs. Size of the nearest wetland, wetland proximity, and wetland adjacency consistently and significantly impact nearby housing sales price. Similar to Savannah's and the overall Chatham County's final model, decreasing the distance to wetland generally increases housing sales prices. But the magnitude of significance or the coefficient sign of the variable is further determined by the specific type of wetlands involved. Consistent with the findings from Pooler's and Chatham County's final model, residents generally prefer to live closer to a small wetland. But in unincorporated area such preference for size of a nearby wetland further depends on the specific type of the wetland. A large 'fresh pond' or 'forest shrub' nearest wetland is desirable for residents or homebuyers in unincorporated area. But similar to the finding from Pooler's final model, the dismenities effect of forested wetlands is also revealed in the unincorporated area. Adjacency to a forested wetland has a negative impact on housing prices.

Table 6-7 Determinants of Final Model in Unincorporated Area

Variable	**B**	**Std. Error**	**Sig.**	**Collinearity Statistics**	
(Constant)	7.652	.207	.000***	**Tolerance**	**VIF**
Lot size (log)	.190	.012	.000***	.533	1.878
Living area (log)	.181	.014	.000***	.517	1.934
Bedrooms	.033	.012	.005**	.803	1.245
Bathrooms	.137	.014	.000***	.585	1.709
Building quality	.271	.013	.000***	.466	2.145
Building age	-.002	.001	.000***	.477	2.097
Distance to the nearest historic district (log)	.047	.018	.009**	.479	2.088
Distance to the nearest highway (log)	.040	.005	.000***	.623	1.605
School district 1	.155	.018	.000***	.422	2.371
School district 4	.162	.014	.000***	.390	1.585
100-year floodplains (AE) *Marine	.099	.015	.000***	.631	1.744
Planned united development (PUD)	.096	.012	.000***	.565	1.771
Residential agriculture (RA)	-.063	.020	.002***	.421	2.377
Wetland size (log)	-.012	.003	.000***	.458	2.183
Wetland size *Forest	.010	.004	.011*	.411	2.432
Wetland size *Fresh pond	.020	.007	.006**	.694	1.441
100 wetland setback *Marine	-.122	.046	.008**	.331	3.022
Distance to the nearest wetland (log)	-.018	.005	.001***	.601	1.665
Wetland adjacency *Marine	.153	.045	.001***	.329	3.040
Wetland adjacency *Forest	-.031	.017	.050*	.728	1.374
The acreage of wetlands within 1/4 mile	.011	.002	.000***	.676	1.479

R = 0.78; R square = 0.60; Adjusted R Square 0.60

Similar to the findings from the overall model, wetland setback zones located along with marine wetlands nearby have negative impacts on single family homes. Surprisingly, environmental overlay zone is statistically insignificant. The results are partially due to the facts that the majority of single family homes in unincorporated area are located within environmental overlay zones, and only residents living very close to a wetland (within 100 ft setback zone of the wetland) are significantly impacted by wetland regulations.

Only one of wetland quantities variables (i.e. the acreage of wetlands within a quarter mile) significantly impacts the sales prices of single family homes. The result indicates that residents in unincorporated area prefer to have a large amount of wetlands in their neighborhoods within a walking distance. However, compared to the significant impacts from other wetland attributes, insignificance of the majority of wetland quantities variables strongly suggests that residents care more about their immediate private access to wetlands and their immediate surrounding wetlands' characteristics and conditions than the ambient levels of wetland amenities indicated by the number and acreage of wetlands in their neighborhood.

In brief, single family home owners in unincorporated area generally enjoy immediate private access to wetlands, but their willingness to pay for the immediate access to wetland amenities largely depends on the types of wetlands involved. The results further imply that when the supply of wetland amenities is ample, home buyers are more willing to pay for desirable types of wetland and high level of private access to the desired wetlands than the 'quantities' of wetlands available in their neighborhood. Wetland disamenities are more easily revealed in both a rural study setting (i.e. Pooler) and a suburban setting (i.e. unincorporated area) where the scarcity of wetlands is not an issue. In Pooler forest shrub is the dominant type of wetland, no preferences for other types of wetlands are revealed in its final model. But in unincorporated area, since three types of wetlands are evenly distributed, preferences for types of wetlands are fully revealed.

6.5.4 The Implicit Prices of Wetland Attributes

Implicit market prices for wetland attributes are computed using the coefficient estimates presented in Table 6-7. Using the same approach as Mahan et al. (2000), the marginal implicit prices of non-logged wetland amenity variables are equal to the coefficients multiplied by the mean house price in unincorporated area (i.e. \$169,409), adjacency to a marine wetland increases property sales price by around \$25,920. But if the wetland is 'forest shrub', the sales price is decreased by \$5,252 dollars. If a single family home is located within 100 'marine' wetland setback zones, its sales price is averagely reduced by \$20,668. Using the mean sale price and the maximum distance to nearest wetland of 1722 ft, the marginal implicit price is $(-.018 \times \$\ 169{,}409)/1{,}722 = \$1.7708$. Moving 1,000ft closer to a wetland increases the average house value by \$1,771.

6.6 Summary

6.6.1 The Effects of Non-wetland Variables

Hedonic models analyzed in the Chapter show that structural variables significantly impact housing sales price, and explain the largest portion of variances of the sales price. R square produced by structural-only models is about 0.45. Structural variables have expected signs, and are consistently significant across the three areas.

The impacts of neighborhood and locational variables on housing sales price vary across the three areas. Neighborhood characteristics such as school districts, planned united development, and residential agriculture have significant impacts on the sales price only in unincorporated area due to their statistical representativeness. Proximity to a park increases a nearby house's sales price in an urban setting, but turns into insignificant in rural and suburban area where open spaces are ample. Proximity to historic districts (or Savannah downtown area) and highways lowers property vales across the three areas, which could be explained by the fact that proximity to these features might expose a property to greater traffic congestion and noise. 100-year floodplains associated with forest wetlands have negative impacts on properties within the plains in Pooler. But in unincorporated area, 100 years floodplains associated with marine wetlands have positive impacts on the properties. The difference is largely related to the amenity effects of different types of wetlands: non–open water and open water featured wetlands.

6.6.2 The Effects of Wetland Amenity in Different Settings

Based on the analysis above, it is safely concluded that wetlands do matter to nearby residents. The amenity value of wetlands does varies across different types of study setting, so do the impacts of individual wetland attributes on housing price. The magnitude of wetland amenity effects is largely related to the characteristics of a study setting. In a rural setting where wetland resources are ample and sufficient. Wetland amenities have nearly no positive impacts on nearby housing sales price. Wetland proximity and a large nearest wetland decrease the nearby housing sales price. Type OF wetland and size of the nearest wetland, and wetland proximity play dominant roles in explaining the amenity value of wetlands in a rural setting.

In an urban setting where wetland resources are extremely limited, wetlands have most significant and positive impacts on nearby housing price among the three sub-study areas. The scarcity of wetland supply dramatically increases the role of wetland amenity value in a hedonic model. No disamenity effects of wetlands are reflected in the model. Size of the nearest wetland, wetland proximity, and environmental overlay zone are the three key contributing variables in explaining the amenity value of wetlands. Types of the nearest wetland turn into insignificant in an urban setting.

In a suburban area where wetland recourses are ample and diverse in term of types and quantities of wetlands, both dismenities and amenities of wetlands are revealed in its final model. Immediate private access to wetlands (i.e. adjacency or proximity to the wetland) in general positively impact nearby housing price. A large nearest wetland and wetland setback zone negatively impacts nearby property values. Interacted with types of wetland, wetland adjacency and size of the nearest wetland generate either positive or negative impacts on the housing prices.

The low R squares of final models for Pooler, unincorporated area, and Chatham County do pose concerns about if hedonic model is appropriate to estimate the amenity value of wetlands in rural areas or the areas with ample open-space resources, and also if some other important housing attributes such as locational variables are omitted from the study. Further investigations and discussions are necessary to understand the mechanisms of how wetland amenities are valued by nearby residents in rural and suburban area.

CHAPTER VII

CONCLUSIONS AND DISCUSSIONS

This study estimates the amenity value of wetlands to nearby residents in Chatham County, GA. The findings suggest that wetland amenity value is decided by a bundle of wetland attributes, and vary widely by location, by type of wetlands. It is the characteristics of a study setting and the characteristics of wetlands together that decide how and to what extent wetlands impact the sales prices of nearby single family homes. The Chapter is organized to explain how each wetland attribute impacts housing sales price, and compare the findings with prior relevant studies. Relevant conclusions and discussions are developed in the process.

7.1 Wetland Basic Characteristics and Conditions

Wetland basic characteristics and conditions have significant impacts on nearby housing sales price, but the magnitude and direction of the effects depend on both wetland characteristics such as types of the nearest wetland, size of the wetland, and characteristics of a study setting. Interacting with other wetland attributes, different types of wetland generate either additional costs or benefits to single family home owners. When types of wetland are evenly distributed in a study area, preferences for types of wetland can be fully revealed. A study setting with few wetlands or open-space resources drive any type of wetland to become insignificant. A large wetland can generate addition positive or negative impacts on nearby housing sales price, depending on the supply of the wetland in a study setting. The impact of wetland regulations is also related to the characteristics of a study setting.

7.1.1 Wetland Types

Different types of wetland have different impacts on nearby housing price. Forest shrub wetlands tend to be located along rivers and streams, and have a wide variety of vegetation, but the least amount of open-water views. Open-water wetlands are mostly located near shallow ponds, reservoirs, or coastal lines. The literature suggests that open-water wetlands, especially marine wetlands, have significant and positive impacts on the sales prices of residential properties, while forested wetlands have negative effects. Both Mahan et al. (2000) and Doss and Taff (1996) examined the impact of wetland types on the sales prices of residential properties, and found that proximity to open-water wetlands has positive and significant effects. The later study and Bin and Polasky (2005) found the negative impacts of forested wetlands on the sales prices of residential properties.

7.1.1.1 Forested Wetlands

The findings of this study suggest that if forested wetlands are the dominant wetland type in either a rural setting or a setting with plenty of wetlands or open spaces, forested wetlands often negatively impact housing prices due to the amenity features associated with forests such as less open-water views, possibly odor and insects. As Reynolds and Regalado (2002) argued that the type of wetland largely determines whether the presence of a wetland positively or negatively affects land values. They found that forested wetlands in Florida have negative effects on rural land values, and positive effects of fresh-pond wetlands on land values. The amenity effects of forested wetlands vary across different settings. Residents in a suburban setting prefer to live close to a large forest wetland, but not directly adjacent to the forest wetland due to its unfavorable amenity features described above. But in an urban setting, lack of wetlands or open spaces drives any type of wetland insignificant.

7.1.1.2 Open-water Wetlands

Open-water wetlands such as fresh-pond and marine (coastal) wetlands have positive impacts on nearby housing sales price. Coastal wetlands have consistent and positive impacts on the sales prices across the study area due to its open-water amenity features. The strong open-water amenity effects are further supported by the finding that homes within 100-year floodplains with a coastal view have higher sales prices than those outside of the floodplains in unincorporated area. The results are consistent with the studies conducted by Bin and Polasky (2004) and Bin and Kruse (2006). Adjacency to marine wetland is mostly favorable in the study area, even though residents in unincorporated area also prefer to live closer a large fresh-pond wetland.

However, amenity effects of marine wetlands do not consistently change as the distance to a marine wetland increases and waterfront views of the coastal wetland quickly diminish. The study finds that the sales prices of single family homes located within 100ft buffer distance of a marine wetland are negatively impacted by the buffer zone. It is consistent with the study conducted by Mooney and Eisgruber (2001), which estimated the influence of riparian buffers on housing sale prices, and found that the buffers decrease average housing values within the buffers due to a diminished view. The negative impacts could be further explained by the fact that for the majority of single family owners live within 100ft setback zone of a coastal wetland, the costs of living close to the wetland (e.g. flood and erosion risk, and limited development rights) appear to be significant without high compensation from coastal front amenity values associated with only limited amount of properties within the zone.

7.1.2 Wetland Size

Mixed results have been found in prior studies. Mahan et al. (2000) found that increasing the size of the nearest wetland by one acre increases a property's value by $24.39. Bin and Polasky (2005) found that in a rural setting increasing the size of nearest wetland by 25% decreases property value by $217. Lupi et al. (1991) found that a larger size of wetland in areas with lower wetland acreage more significantly increase nearby housing values than in areas with higher wetland acreage.

Consistent with Lupi et al. (1991), this study suggests that a large size of the nearest wetland in general is negatively related to sales prices of nearby single family homes in Pooler and unincorporated area where have lots of open spaces for recreation purpose. A large wetland in rural or suburban area may mean more of a nuisance in term of limiting mobility and development rights, flood concerns, and disease potentials than a scarce amenity. Interestingly, with short supply of open spaces and wetlands in Savannah, a large size of the nearest wetland is positively related to nearby housing sales price. The two contradictory findings suggest the amenity effect of size of the nearest wetland varies across the study area. Local scarcity of wetlands largely determines how size of nearest wetland impact nearby housing price. The positive effect of a large wetland generated in an urban setting is mostly because of frequent onsite-use of the wetland by nearby residents. But in rural or suburban area with plenty of wetlands or open spaces around, a large wetland is more likely protected by environmental regulations, which further results in less frequent onsite-uses, and therefore appear to less valuable to nearby residents.

In conclusion, the amenity effects of the size of the nearest wetland on residential property values depend on both the characteristics of a study setting and the types of wetlands involved. For instance, this study finds that a large size of the nearest forested wetland is much more favorable in a suburban setting than in a rural setting; and that in suburban setting, a large size of fresh-pond wetlands is less desirable than a large coastal wetland.

7.1.3 Wetland Regulations

Environmental zoning and setback requirements are consequences of protecting wetland amenities located on or near a property. A few studies have found that natural amenities protected by existing environmental overlay zones increase the sales price of residential properties within the zones (Lutzenhiser and Netusil 2001). Sims and Schuetz (2009) stated that environmental overlay zones increase the value of existing homes by constraining the supply of additional homes within the zones. Netusil (2005) summarized that the effect of environmental zoning on a property’s sale price is uncertain, and varies across study regions due to several factors such as location of study areas, development burdens, and homebuyers’ perceptions of environmental zoning.

Environmental overlay zones in different types of setting have different impacts on housing price. In an urban setting, environmental overlay zone effectively limits the supply of homes within the zone, and preserves the environment quality of neighborhoods, and therefore generates benefits to residential properties within the zone. But in rural area where property owners tend to convert wetlands into a more profitable land use, environmental zoning should be an effective regulation tool to prevent such conversion activities. The negative impacts of environmental overlay zone on properties values are therefore expected in Pooler and unincorporated area because the regulation limits the property owners' future development rights. However, no significant negative regulation effects are found in the two areas.

100-feet setback buffer zone was established to protect the wetlands near residential properties in the study area. Similar to the results from Shilling et al. (1991), no significant negative regulation effects of wetland setback requirement are found in rural and urban area. But in coastal area 100 feet setback buffers have negative impacts on housing prices within the zones. But as Money and Eisgruber (2001) argued, the negative impacts are more due to the quickly diminishing amenity effects of water features than the regulation effects of the buffer zones.

7.2 Wetland Accessibility

7.2.1 Wetland Adjacency

Adjacency to wetlands means extending a home's side yard or backyard, and viewing or using the wetlands from the residential lot. It generates a higher level of utilities of wetlands than wetland proximity. Adjacency to a wetland generally has a positive impact on the sales prices of single family homes, especially when the wetland has open-water features. The findings are consistent with previous hedonic studies.

Mooney and Eisgruber (2001) found that stream frontage in the Mohawk watershed in western Oregon increases property values by 7%. Spalatro and Provencher (2001) examined the lakefront properties in northern Wisconsin, and concluded that the average price of lakefront properties is increased by 21.5% due to the amenity effects of lakes. Bin and Polasky (2004; 2006) found that coastal view strongly increases property values, despite of high flood risk involved.

However, the sign and the magnitude of the effect are location dependent. In an urban setting where wetland resources are sparsely distributed, adjacency to a wetland has a strong positive impact on housing prices. In a rural or a suburban setting with ample open spaces surrounded, the effect of adjacency to a wetland mainly depends on if the type of the wetland has favorable features to local residents. For instance, in Pooler and unincorporated area adjacency to an unfavorable type of wetlands such as forested wetlands decreases nearby housing prices.

7.2.2 Wetland Proximity

Previous studies have found that decreasing distance to amenities such as wetlands, natural areas, and streams increase nearby housing sales prices (Doss and Taff 1996; Mahan et al. 2000; Tyrvainen and Miettinen 2000; Mooney and Eisgruber 2001). But Bin and Polasky (2005) found that in a rural setting decreasing the distance to wetlands by 25% decreases property value by $945. Nelson (1986; 1988) estimated rural and urban properties separately using proximity to greenbelt. He concluded that urban residents see the greenbelt as a valuable amenity capitalized into land prices, but to rural farmers it is a negative externality of being closer to urban activities.

Convincing evidence about how the effects of wetland proximity vary by study location is found in the study. In a rural setting, decreasing distance to a wetland decreases nearby property values, while in a suburban setting, decreasing distance to a wetland increase the property values. However, proximity to wetland is insignificant in Savannah where single family home residents are more willing to pay for adjacency to a wetland. The result implies that urban residents prefer to have a higher level of private access to a wetland through living immediately adjacent to the wetland.

The findings also indicate that residents prefer living closer one type of wetland over the other. Mahan et al. (2000) found that proximity to a forest wetland has a negative impact on a property' sales price while proximity to open water is found to be positive and statistically significant. Proximity to streams or lakes is also found to be positive in their study. Interactive items between wetland proximity and types of wetland are developed in the study to understand the additional impacts of wetland proximity decided by the type of the nearest wetland on housing sales price. Preferences for different types of wetland have been discussed in Section 7.1.1.

In conclusion, increasing the level of private access to wetlands increase the amenity effects of wetlands on housing price either positively or negatively, depending on the type of the wetlands and the characteristics of study setting.

7.3 Neighborhood Wetland Effects

Neighborhood wetland effects describe the ambient levels of wetland amenities measured by the relative quantities of wetlands available in a property's surrounding neighborhoods. Netusil (2005) argued that a property's sales price partially depends on amenities on the property and amenities in its surrounding neighborhood. A high ambient level of wetlands in a neighborhood is expected having significant impacts on the sales prices of single family homes in the neighborhood. But disappointingly only one variable appears significant in the final models: increasing acreage of wetlands within a quarter mile of walk distance is desirable in unincorporated area. The result suggests that wetland amenities are mostly valued by providing ‘privatized’ value to nearby residents in term of its direct view of and access to a wetland. Residents less likely walk over a far distance to use wetland resources in their neighborhood, if they are able to access to ample open-space resources immediately surrounding with their homes.

7.4 Conclusions

This study analyzes a series of hedonic models to build a thorough understanding of how wetland amenities impact the sales prices of single family homes in Chatham County, an area rich in wetland resources. Three sub-study areas (i.e. Pooler, Savannah, and unincorporated) are analyzed, which represents rural, urban and suburban setting respectively. Of them, Pooler is subject to the least development pressure and Savannah the most. Unincorporated area has some development pressure. Wetlands are expected have highest impacts on housing price in Savannah than other two sub-study areas.

A variety of variables are considered contributing to explaining the amenity value of wetlands, but only wetland characteristics and wetland accessibility variables are found strongly significant in this study. Neighborhood amenity variables show nearly no impacts on the sales prices. Specifically, this study yields three important insights: first, residents’ preferences for types of wetland are consistent across different study settings.

Homebuyers are more willing to pay for open-water wetlands than the wetlands with less open-water features such as forest-shrub wetlands. The positive amenity value of open-water wetlands is strongly revealed in the housing market, especially in a coastal area.

Second, a high level of private access to wetlands (i.e. wetland adjacency) is highly valued by residents living in urban neighborhoods. Suburban residents do not appear to value proximity to wetland as highly, rural area are even less. Therefore, results from studies that focus on urban locations should not be used to draw policy implications for suburban planning, and especially for rural town planning.

Third, the amenity value of wetlands is highly location dependent, and varies depending on whether the wetlands are in urban or suburban location versus a rural one. In a rural setting where wetland resources are sufficient, wetlands have nearly no positive impacts on nearby housing sales prices. Hedonic models only pick up the disamenities of rural wetlands. The negative impacts only mean that rural residents are not willing to pay for a premium to locate near wetlands, which does not imply wetlands have no value in a rural setting (Landry and Hindsley 2007).

In an urban setting, the scarcity of wetlands leads to strong positive impacts of wetlands on nearby housing sales price. No disamenities of wetlands are revealed in hedonic models. In suburban area, the diversity of wetlands especially in term of types of wetland results in mixed amenity effects of wetlands. A wetland can be either an amenity or disamenity to nearby residents, depending on the type of the wetland. In brief, the varying results suggest that amenity value of wetlands is decided by the characteristics of wetland considered, the relative scarcity of the wetland, and the characteristics or locations of study regions.

7.5 Discussions

7.5.1 Contributions

This study deals with a range of theoretical and empirical issues associated with valuing wetlands through hedonic methods. It investigates how and to what extent wetland amenities impact the sales prices of single family homes through surveying and synthesizing all relevant studies. Anderson and West (2003) argued that it is important to jointly consider a variety of attributes provided by open spaces in hedonic price studies to understand the amenity value of open spaces.

This study confirms the hypothesis proposed by Bin and Polasky (2005) that environmental amenity value is largely decided by the extent of local scarcity of the resource. Comparison of findings across Savannah Chatham metropolitan housing market provides convincing evidence of spatial variation in wetland amenity effects. This study finds the amenity value of wetlands spatially varies using separate hedonic price models for different sub-study areas. It calls into question the earlier studies using an aggregate house sales data based on the assumption that wetlands amenity effects are constant across a study region.

This study uses a long-term dataset to estimate the amenity effect of wetlands. The study design accounts for the dynamic change of a housing market over a long-period time to overcome the flaw of previous studies of wetland amenity values based on house sales over only a short period of time. Riddel (2001) argued that valuing open spaces based on a short period of data are problematic. Because it yields a lag between open space purchase and the time when the open space effects are fully capitalized into house prices.

Omitted variable bias has long been a concern in hedonic price studies, new wetland attributes are developed to fully enumerate the amenity value of wetlands accrued to nearby residents at both residential lot and neighborhood level. Furthermore, including both wetland attributes and their interaction terms is helpful in interpreting exactly how wetlands value to nearby residents, and additional mingled effects between wetland attributes.

7.5.2 Policy Implications

Concerns over the preservation of wetlands have been growing as development pressures increase. Preservation programs (e.g. local zoning regulations) and expenditure decisions (e.g. purchases of conservation easement) are hardly based on a convincing cost and benefit analysis because of the lack of the dollar estimate of the size of the benefits. A few survey studies of wetlands have suggested that local residents value wetlands (Carlsson et al. 2003; Stevens et al. 1995). However, only economic analyses relying on well established statistical techniques, extensive data, and scientific research methodologies can provide reliable evidence about the dollar value of these important non-market goods. Furthermore, such economic estimates are also important in policy debate processes. Given constrained government budgets and increasing land values in development, it is important to figure out how and where to target for wetland preservation, what types of wetlands are the most desirable, and whether a smaller area or a larger area of wetlands is more valuable, or wetlands in a more distant location vs. those closer to residential property owners.

This study generates a very important policy implication: urban planners and developers need to think about spatial context when making policy decisions about providing or protecting wetland amenities. For instance, the results of the study show dramatically different preferences for the type of wetland and size of the nearest wetlands in rural vs. urban and suburban area. Decision makers may consider adjusting wetland policies based on their spatial context to generate net benefits to local community. In Pooler, positive amenity effects of wetlands will motivate wetland owners or developers to preserve wetlands, and therefore less public intervention is needed for wetland protection. Negative effects on housing property value in Pooler will alert decision makers that strict protection policies are needed to prevent wetland conversion activities.

It is very difficult to generalize a universal policy guideline based on the wide range of studies that have been conducted. As McConnell and Walls (2005) summarized**,**

The uniqueness of particular open space in a particular region within a particular time period to a particular group of households and housing market decides the amenity value of open space varying widely across regions and sometimes even within a region. It is difficult for policymakers to find a specific dollar value for a particular wetland. The amenity value of wetlands is case study–specific, varying by location, and different methodologies used to estimate the values. However, empirical studies do significantly contribute to increasing public awareness and policy debate of wetland value by relating wetland public environmental good with property owners' own economic benefits, helping policymakers conduct an accurate cost and benefit analysis, and understanding potential fiscal impact on property valuation and tax revenue.

7.5.3 Limitations and Future Studies

Wetlands provide a variety of benefits to local communities such as open spaces, recreation opportunities, aesthetics, ecosystem services, and so forth. This study only estimates the partial value (use value) accrued to nearby private property owners such as seeing or using the open space, having a pleasant view and opportunities for viewing wildlife. Future studies may consider combining hedonic methods and survey methods to estimate both use values and non-use values of wetlands. The combination will contribute to comparing the economic value of wetland amenities estimated from the two approaches. Furthermore, using surveys can help identify the most effective wetland attributes for hedonic model specification. This study draws upon a diverse literature of open spaces including water resources, parks, agriculture open space to capture wetland values accrued to nearby residents. But Mahan et al. (2000) argued that wetlands impact property values differently than lakes, rivers, and parks. Surveys could be very helpful in capturing a more accurate picture of what and how people value wetlands.

Despite the limitation of hedonic method, it still provides useful information, given that it is simpler and less expensive than a survey-based approach. But it is important to think about how the method might be improved. The incorporation of appropriate segmentation of housing markets is critical for future studies. The study shows that the same model estimated with data from different locations yield very different results with respect to wetland amenity value: rural versus urban versus suburban markets. But Landry and Hindsley (2007) suggested in rural or suburban area hedonic method may not be an appropriate method to estimate the amenity value of wetland. New methods need to be explored to value wetland amenities in future studies.

Several additional methodological limitations exist in the study. First, the study doesn't consider other types of open spaces such as river, streams, nor do consider accurate distinctions among the types of wetland. Second, the issue of how to define a wetland buffer around a property is also open for discussion, given the quite different methods used in different studies. For a lot size of two acres and over, its 100ft distance buffer would include a substantial portion of the property itself. The issue is also applied to the situation when proximity or adjacency to a wetland is measured. For instance, the study measures the distance from the centroid of a single family parcel to the nearest edge of wetland polygon. However, since the average size of a parcel is relatively small (around 0.3 acres), the inaccurate measurement issues are insignificant. Third, low R square also raises the concern about the omission of other housing attributes. Unobserved neighborhood characteristics or locational variables, if uncontrolled for, may lead to biased estimates for observed housing characteristics. Fourth, the wetland data used by Chatham County Metropolitan Planning Commission and this study were published in 1992 by National Wetland Inventory. The data is relatively out of date. The accuracy of the inventory may bias the study's results.

In conclusion, although the amenity value of wetlands appear to vary widely by location, by type of wetland, by research methodology, and by study focus, more empirical research are still needed to be conducted but with broader applicability. Policymakers at all levels of government are interested in having good estimates of wetland benefits to local residents.

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RECENT PUBLICATIONS

K. W. Geideman, D. Jourdon, **S. Gao.** "The Impact of Age on the Value of Historic Homes in a Nationally Designated Historic District." *Journal of Real Estate Research* (Forthcoming in 2010).

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